ID No. CH17847
- RETURN TO -
INSTRUMENT CONTROL
SYLVANIA SES -- West

INSTRUCTION MANUAL

MODEL F230A

DATA ROYAL CORPORATION

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12-1-68

TABLE OF CONTENTS

SECTION I

INTRODUCTION

General Description 1-1
Accessories 1-2

SECTION II

INSPECTION AND INSTALLATION

Inspection Upon Receipt 2-1
Rack Mounting 2-2
Combination With Accessories 2-3
Turn-on Procedure 2-4
Operational Checkout 2-5
Controls 2-7

SECTION III

CALIBRATION AND SPECIFICATION VALIDATION

Specifications 3-1
Frequency Calibration 3-7
Frequency Control Adjustments 3-7
Frequency Range and Calibration Accuracy 3-12
Frequency Response 3-14
Distortion (Sine) 3-16
Rise and Fall Time 3-18
Time Symmetry 3-18
Amplitude Symmetry, Overshoot, Preshoot and Tilt 3-19
Triangle Wave and Ramp Linearity 3-20

SECTION IV

THEORY OF OPERATION

Frequency Control Amplifiers 4-6
Schmitt Trigger 4-7
Constant Current Generator 4-8
Integrating Amplifier 4-9
Sine Generator 4-9
Square Wave Amplifier 4-11
Ramp Generator 4-11

SECTION V

MAINTENANCE

General 5-1
Preventative Maintenance 5-1
Corrective Maintenance 5-1
Troubleshooting Aid 5-2
Voltage Levels 5-4
Parts List, Generator Board Assembly 5-7
Parts List, Frequency Control Board Assembly 5-21
Parts List, Master Board Assembly 5-25
Parts List, Sawtooth Board Assembly 5-40
Parts List, Range Board Assembly 5-46
Parts List, Front Panel Assembly 5-49

SECTION VI

RECOMMENDED SPARE PARTS

Recommended Spare Parts 6-1

ILLUSTRATIONS AND SCHEMATICS

Figure 2-1 Rack Mounting 2-2
2-2 Combinations Of Instruments 2-3
2-3 Combinations with Accessories 2-4
2-4 Operating Controls 2-7
3-1 Master Board, Test Points and Calibration Adjustments ... 3-3
3-2 Gen. Board, Test Points and Calibration Adjustments 3-4
3-3 Freq. Control Board, Test Points and Cal. Adjustments ... 3-8
3-4 Sawtooth Gen. Board, Test Points and Cal. Adjustments ... 3-10
3-5 Frequency Range and Calibration Accuracy 3-13
3-6 Frequency Range and Calibration Accuracy 3-14
3-7 Frequency Response 3-15
3-8 Frequency Response 3-15
3-9 Frequency Response 3-16
3-10 Distortion (Sine) 3-17
3-11 Distortion (Sine) 3-17
3-12 Rise and Fall Time; Time Symmetry; Amplitude Symmetry Overshoot, Preshoot and Tilt 3-18
3-13 Time Symmetry 3-19
3-14 Triangle Wave and Ramp Linearity 3-20
5-2 Generator Board Assembly, Parts Call-out 5-14
5-3 Generator Board Assembly, Parts Call-out 5-15

Schem. 1	Lock-up Amplifier	5-16
2	Schmitt Trigger	5-17
3	Constant Current Generator	5-18
4	Integrator	5-19
5	Sine Circuits	5-20
Figure 5-4	Frequency Control Board, Parts Call-out	5-23
Schem. 6	Frequency Control	5-24
Figure 5-5	Master Board Assembly, Parts Call-out	5-32
5-6	Master Board Assembly, Parts Call-out	5-33
Schem. 7	Power Supply	5-34
8	Square and Ramp Circuits	5-35
9	Output Amplifier	5-36
10	Push Button Circuits	5-37
11	Trigger Circuits	5-38
12	180° Amplifier	5-39
Figure 5-7	Sawtooth Generator Board, Parts Call-out	5-43
Schem. 13	Integrator Circuits	5-44
14	Schmitt and Logic Circuits	5-45
Figure 5-8	Range Board Assembly, Parts Call-out	5-47
Schem. 15	Range and Sweep Circuits	5-48
Figure 5-9	Front Panel Assembly, Parts Call-out	5-50
5-10	Rear Panel Assembly, Parts Call-out	5-51

SECTION I

INTRODUCTION

The Data Royal Model F230A is a high frequency Waveform/Triggered Sweep Generator. The F230A provides continously variable selection of frequency from .005Hz to 3 MHz by means of 16 possible switch combinations and a 20:1 vernier control.

The Model F230A provides Square, Sine, Triangle and Ramp outputs of up to 16.25 volts peak-to-peak, selectable by push button function switches on the front panel. In addition, fixed level outputs of all waveforms are simultaneously available on BNC connectors on the rear panel. All rear outputs have 50Ω output impedances, while both 50Ω and 600Ω connectors are provided for the front panel outputs. All front panel outputs can be offset for any combination of DC offset and signal peak amplitude of ±16.25 v. This is accomplished by means of a Rear Panel slide switch. An additional output connector is provided on the Rear Panel, which delivers an output signal, which is 180° out of phase with the selected Front Panel output.

The Model F230A contains an internal Sawtooth Generator, which can be used to trigger the oscillator to deliver pulses or tone bursts, the repetition rate of which is determined by the Sweep Frequency Control setting. This is accomplished by feeding the Monitor Output into the Trigger Input connector on the Front Panel

INSTALLATION

INSTALLATION

SECTION II

INSPECTION AND INSTALLATION

Your Data Royal Generator is ready for use immediately upon receipt. Make the following checks, however, to assure that no damage has occured during shipment.

1. Inspect the shipping container prior to acceptance from the carrier. Note any damage to the shipping container on the carrier's receipt.

2. Inspect the instrument for damage. Check for dents, scratches, broken knobs, connectors, etc.

3. Remove the top and bottom covers and inspect for broken components or hardware.

4. If damage is not apparent until after the instrument has been accepted, file a claim for concealed damage with the carrier within 15 days after receipt. All packaging material must be kept for inspection by the carrier's agent. A copy of the claim must be forwarded to Data Royal Corporation.

RACK MOUNTING:

Data Royal Generators are ready for bench operation as shipped from the factory. If specifically ordered, the necessary parts for rack mounting are packaged with the instrument. To convert to rack installation refer to Figure 2-1 and proceed as follows:

1. Remove the (4) rubber feet and the instrument bail.
2. Remove the Filler Panels from botn sides.
3. Install the Rack Mounting Brackets using the #10 screws provided. The instrument is now ready to mount in a standard (19 inch) rack.

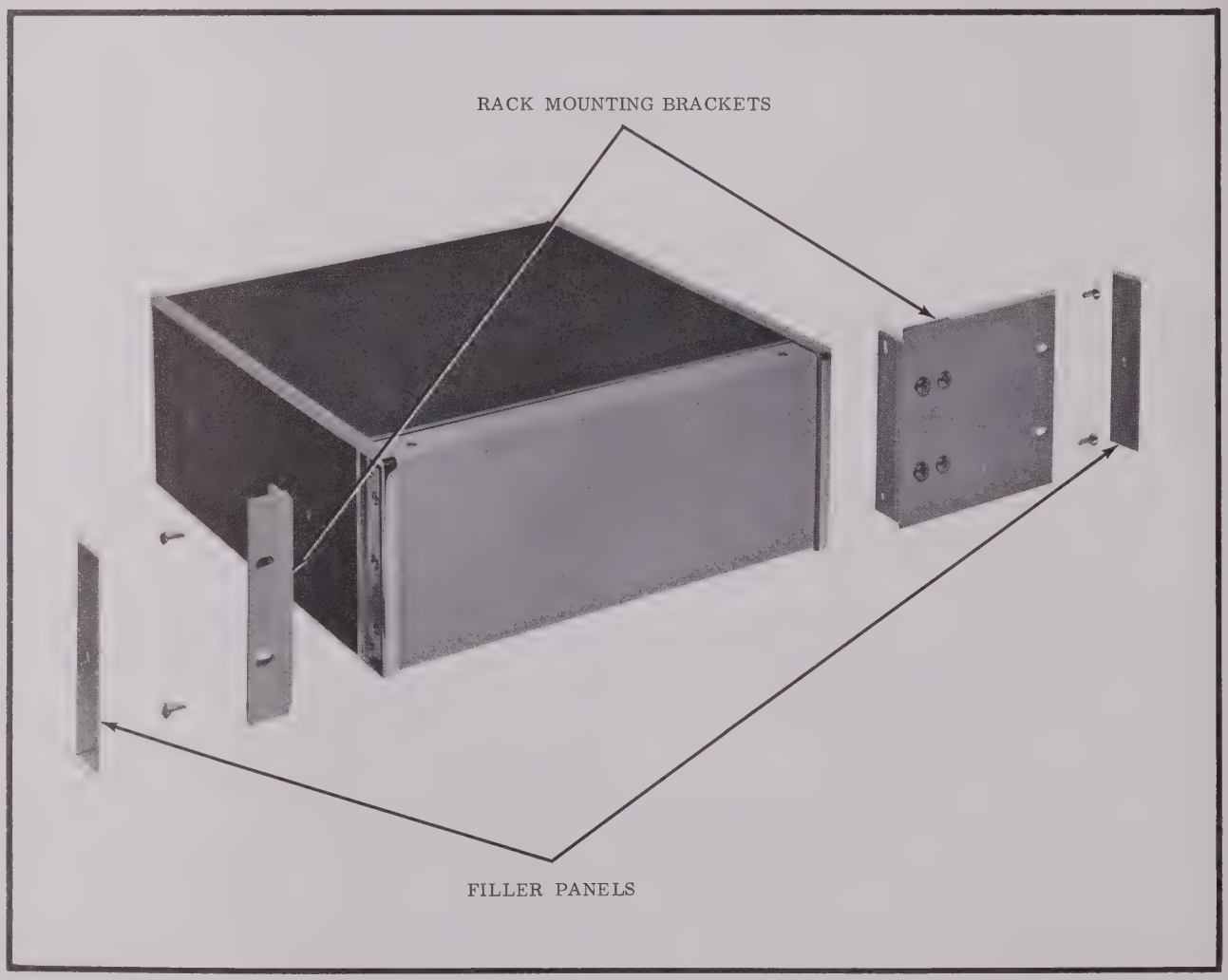


FIGURE 2-1

FIGURE	INSTRUMENT/ACCESSORY COMBINATION	MOUNTING KIT PART NO.
1	F230A	26-07651-1
2	F230A + one accessory	26-07652-1

FIGURE 2-2

COMBINATION WITH ACCESSORIES:

Each Generator can be combined with any Data Royal F900 Series Accessory, for ease of handling and conservation of space. With the appropriate Rack Mounting Kit the instrument can be mounted in a standard 19" rack. (See Figure 2-2)

To combine two instruments, refer to Figure 2-3 and proceed as follows:

1. Remove the top and bottom covers from both instruments.
2. Remove the Filler Panels from the sides to be joined.
3. Remove the Mounting Clips from both instruments. (Under the top flange of front panel, held in place with #6-32 screw through the flange).
4. Remove the Angle mounted on the rear panel.
5. Insert the Mounting Clips in the rectangular holes at the top and bottom of the side rail near the front.
6. Secure the Mounting Clips with #6-32 screws removed in step 3 and spares provided.
7. Mount the Angle on the rear of the adjoining side rails, using the #6-32 screws provided.
8. Replace the top and bottom covers.

The procedure for attaching the Mounting Kit remains unchanged.

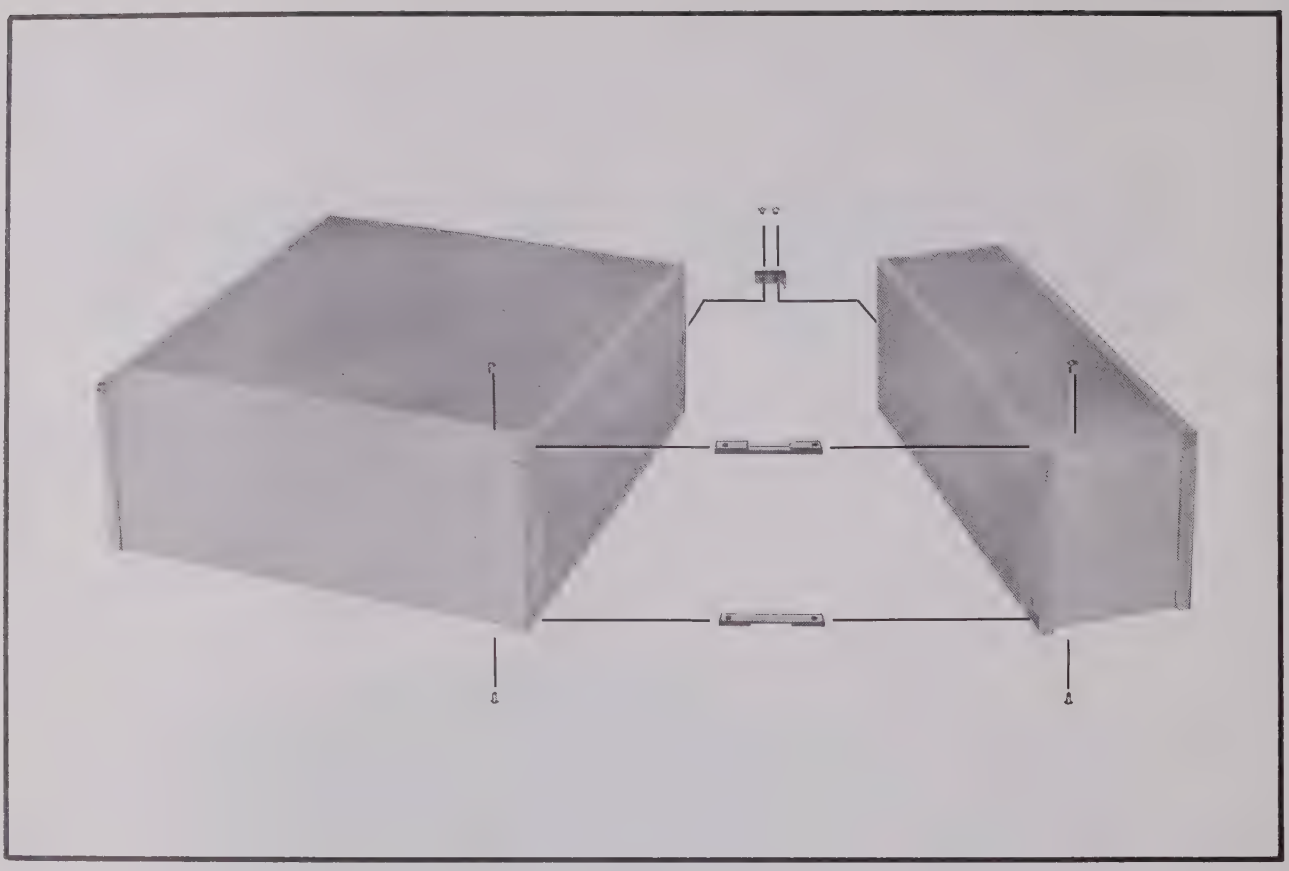


FIGURE 2-3

TURN ON PROCEDURE:

Data Royal instruments may be operated from either 115V or 230V power lines. A switch is provided on the rear panel for quick conversion. For 115V operation the switch must be in the UP position (115 showing).

NOTE:

If the instrument is to be used on a 230V line, make sure the switch is down (230 showing). Also, the line fuse should be changed to an equivalent type, but one-half the current rating.

OPERATIONAL CHECKOUT:

The operational checkout is a preliminary test and is not intended to confirm performance specifications. (For complete specification validation procedure refer to Section III).

The only equipment required for the operational checkout is an oscilloscope capable of displaying a waveform of up to 3 Mc.

To perform the operational checkout proceed as follows:

1. Depress the OFF Function Switch.

2. Insert the power cord into a 3-wire 115/230 volt, 60-400 Hz, single phase power line outlet.

3. Position F230A controls as follows:

a.	Function	Sine
b.	Frequency Range	X1K
c.	Range Multiplier	X1
d.	Frequency Dial	5
e.	Attenuator	0dB
f.	Amplitude	Clockwise
g.	Mode	Normal
h.	Offset	Release

4. Observe that the pilot light comes on at this time. (The pilot light is driven from an internal supply).

5. Connect an oscilloscope first to the 50 ohm, and then to the 600 ohm output connectors. Observe that the frequency is approximately 5 KHz.

6. Vary the Amplitude Control from MIN to MAX. Observe that the output level varies correspondingly, as indicated on the oscilloscope. Turn the Amplitude Control to its MAX position.

7. Position the Attenuator to its -20dB position. Observe that the output level drops by a factor of 10.

8. Position the Attenuator to its -40dB position. Observe that the output level drops by a factor of 10 again.

9. Vary the Frequency Dial from 1 to 10. Observe that the frequency increases correspondingly, as indicated on the oscilloscope.

10. Repeat Step 9 for the other Frequency Ranges.

11. Position the Range Multiplier Switch to X3.

12. Repeat Steps 9 and 10.

13. Position all controls as in Step 3.

14. Depress the Square, Sine, Triangle and Ramp Function Switches, and observe that the output waveform changes accordingly.

15. Connect the oscilloscope to the SYNC Output terminal.

16. Observe that the SYNC Pulse is at least -10 volts in amplitude, and a maximum of 5 μseconds in duration.

17. Connect the oscilloscope to each of the output connectors on the rear panel, and observe that all signals are present.

18. Position all controls as in Step 3.

19. Depress the Repetitive Sweep push Button.

20. Connect the oscilloscope to the Front Panel 50Ω Output Connector.

21. Position the Sweep Rate Control to 1 and the Vernier Control fully clockwise.

22. Observe that the frequency of the output signal varies from the Dial setting to the upper limit set by the Calibrated Sweep Width Controls, at the rate of 1 sweep per second.

23. Position the Sweep Rate to 100.

24. Depress the Triggered Mode push button.

25. Apply the signal from the monitor output connector on the rear panel to the Trigger Input Connector on the Front Panel.

26. Vary the Trigger Level Control until 1 cycle of output signal is obtained.

27. Depress the Gate Mode push button.

28. Vary the Trigger Level Control and observe that tone bursts of varying durations can be obtained.

29. Turn the Trigger Level control to one end. (Out of the circuit.)

30. Depress the Manual Mode push button.

31. Observe that the Generator is running for as long as the Manual push button is depressed.

32. Depress the Normal Mode push button.

If the instrument fails during any portion of the operational checkout, notify your local Data Royal representative immediately. The representative will arrange the repair or replacement of your instrument at the earliest possible moment.

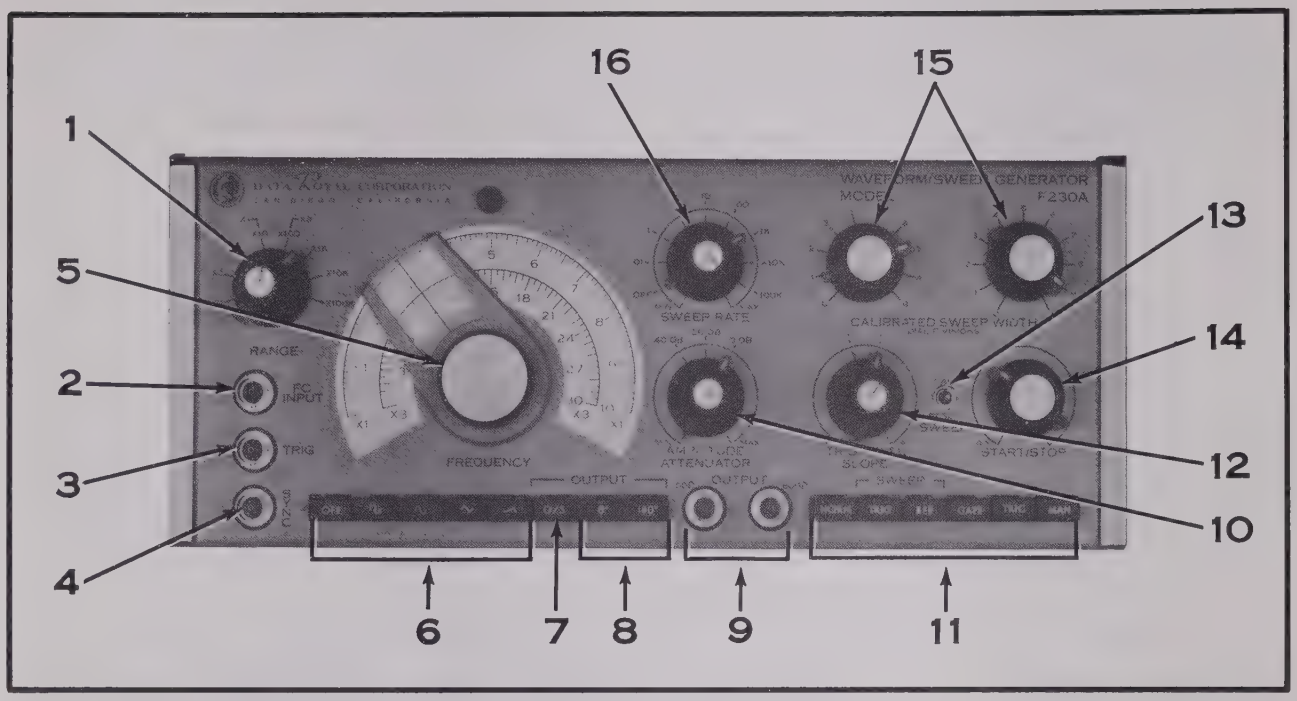


FIGURE 2-4

CONTROLS:

1. Range and Range Multiplier Switch. Concentric switches, which determine the RC networks for the Integrating amplifier.

2. External Frequency Control Input. Enables the F230A output frequency to be controlled from an outside signal sourse, thus the F230A can provide Frequency Modualtion or Frequency Shift output signals.

3. Trigger Input Connector. Trigger signal applied when in the TRIGGERED, GATED or TRIGGERED SWEEP Modes.

4. Sync Output. Provides a Sync signal of -10 volt amplitude, at same frequency as the output signal.

5. Frequency Dial and Control. Marked in X1 and X3 ranges to correspond to the Range and Range Multiplier switches.

6. Function Switches and Power OFF. Selects the desired waveform as marked on each switch. Power is ON when one of the Function Switches is depressed.

7. Offset. Cuts the amplitude of the output signal in half. Activation of the Offset Switch on the Rear Panel enables the output signal to be offset from 0 volts reference. Amount of offset can be any combination of peak signal amplitude and DC injected, up to ±16.25 volts. For normal operation the Offset Switch on the REAR

will be in the OUT Position.

8. Output Amplifier Selector. In normal operation the 0° push button will be depressed. Depressing the 180° push button inserts an inverting amplifier between the Oscillator and the Output Power Amplifier.

9. Output connectors provide output impedances of 50Ω and 600Ω, respectively. Output is floated from the chassis and from Earth Ground.

10. Attenuator and Amplitude Controls. Varies the output signal level in fixed steps of 0dB, -20dB, and -40dB. Amplitude Control varies the output over a range of >20dB within each range.

11. Mode Switches.
(a) NORMAL. Depressed for normal operation of the Generator.

(b) TRIGGERED SWEEP. No output from the Generator until a Trigger command iniates a single sweep; upon completion the Generator resets to original frequency and stops.

(c) REPETITIVE SWEEP. The Sawtooth signal from the internal Sawtooth Generator is connected to the FC Input Connector. Therefore, the Output Signal changes frequency from the dial setting to the higher frequency as established by the Sweep Width Control, and at the Sweep Rate set by the Sweep Rate Control. SWEEP RESET Toggle switch provided to interrupt the sawtooth and reset the Generator to original frequency.

(d) GATED. Application of a trigger signal allows the Generator to operate until the trigger signal or gate is removed, at which time the last cycle will be completed.

(e)TRIGGERED. One complete cycle is generated upon application of a trigger signal.

(f) MANUAL. This switch overrides either the triggered or the Gated mode Switches. When the Triggered mode is selected, depression of the MANUAL Switch issues a simulated Trigger pulse, and the generator will run for one complete cycle. If Gated Mode is selected, depression of the MANUAL Switch issues a simulated Gate signal, and the Generator will run for as long as the MANUAL Switch is depressed.

12. Trigger Level and Trigger Slope Control. Adjusts the sensitivity of the internal trigger amplifier, and enables the trigger amplifier to respond to either a positive or a negative going trigger signal.

13. Sweep Reset Toggle Switch. Provided to interrupt the sawtooth and reset the Generator to its orignal frequency. In the CAL position the peak amplitude of the sawtooth as selected by the Sweep Width Control is switched into the FC Input Connector. This allows the user to adjust the Sweep Width Control for the exact High End frequency of the sweep. This switch is spring loaded so it will return to its normally off position when released.

14. Start/Stop Control. Determines the start and stop point of the cycle generated when in the Triggered Mode. A Sine-Squared pulse can be generated by selecting Sine Wave, Offset and setting the Start/Stop Control at the calibrated +90° or -90° position.

15. Calibrated Sweep Width Control. Determines the peak amplitude of the Sawtooth. Inasmuch as the sawtooth is connected to the FC Input in the Sweep Modes, this will determine the amount of frequency change of the Generator, or the width of the sweep.

16. Sweep Rate Control. Determines the frequency of the internal Sawtooth Generator by 8 fixed range positions and a vernier control. The Vernier must be in its Clockwise position to achieve the frequency as indicated in the fixed positions.

CALIBRATION

SECTION III

CALIBRATION AND SPECIFICATION VALIDATION

SPECIFICATIONS

OUTPUT WAVE FORMS: Sine, Square, Triangle, Ramp and Offset Sine wave forms simultaneously available at the rear; 0° or 180° phase selection provided. All outputs are synchronized.

FREQUENCY RANGES: .005Hz to 3MHz in 16 continuously variable ranges of 1 and 3 combinations with a 100:1 frequency ratio. Vernier control provided by 3:1 dial gear ratio.

OUTPUT VOLTAGE:

Front Panel: Continuously variable by fixed output attenuator (0, -20, -40 dB) with output amplitude vernier of > -20 dB from .03-32.5V p-p (60 dB range); 50 or 600 Ω output impedance. (Ramp and offset sine are 1/2 amplitude.

Rear Panel: Fixed outputs for each wave form with 50 ohms output impedance are simultaneously available as follows: Sine: 2 V p-p; Square: 5 V p-p; Triangle: 2 V p-p; Ramp: 0 to -1 V; Offset Sine: 1 V p-p.

OUTPUT IMPEDANCE:

Front Panel: Both 50 ohms and 600 ohms (BNC Connectors) output impedances are provided for the selected wave form.

Rear Panel: 50 ohm (BNC Connector) output impedance provided for each wave form.

SYNC OUTPUT: > -10 volts (open circuit) pulse for maximum of 5μseconds duration. (Front Panel BNC Connector).

FREQUENCY STABILITY:
Short Term Drift: < ±0.05% of setting for 10 minutes.
Long Term Drift: < ±0.25% of setting for 24 hours.

AMPLITUDE STABILITY:
Short Term: ± 0.05% of maximum output (p-p) for at least 10 minutes.
Long Term: ± 0.25% of maximum output (p-p) for 24 hours.

SYMMETRY (AMPLITUDE): Amplitude of all waveforms is within ± 1% of maximum output (p-p) above ground.

SYMMETRY (TIME):

>99.5%	.005Hz to 100KHz
>99.0%	100KHz to 1MHz
>95.0%	1MHz to 3MHz

SINE WAVE DISTORTION:

<1%,	.005Hz to 100KHz
<2%,	100KHz to 1MHz
<5%,	1MHz to 3MHz

OPERATING TEMPERATURE: 0° C to +50° C

POWER: 115V AC ±10% or 230V AC ±10%, 50 Hz-400Hz; 20 watts.

DIAL ACCURACY: ±1% of full scale, .005Hz to 100 KHz; ±2% of full scale, 100 KHz to 1 MHz; ±3% of full scale, 1MHz to 3 MHz.

FREQUENCY RESPONSE: Amplitude change of <.1dB, .005Hz to 100KHz; <.5dB 100KHz to 3 MHz.

SQUARE WAVE RISE AND FALL TIME:
< 75 nano-seconds

TILT: <0.5% of maximum p-p amplitude.

OVERSHOOT AND PRESHOOT:
<5% of maximum p-p amplitude.

TRIANGLE WAVE AND RAMP LINEARITY:
>99%, .005Hz to 100KHz
>95%, 100KHz to 3MHz

DC OFFSET STABILITY: Within ±.1% of maximum p-p amplitude for 7 days with DC offset control in Off position.

DC OFFSET: Any combination of DC offset and output signal peak amplitude up to ±16.25V (rear panel control).

ISOLATION: Signal output and control input terminals are floating and isolated from case and power line ground.

VOLTAGE CONTROL OF FREQUENCY:
>100:1 frequency ratio for each range with input of 5.00 V DC or wide band AC; front panel input provided (BNC connector). 100 KHz bandwidth; 10K ohms input impedance 0.1% linearity; 1% voltage to frequency repeatability.

CALIBRATION PROCEDURE

Prior to calibration and/or specification validation, the instrument must be placed in the environment of the work area for sufficient time to allow the internal temperature to stabilize.

Warm-up (stabilization) time of 30 minutes is recommended prior to performing the calibration adjustments.

Operational Adjustments.

1. 12 Volt Power Supply Adjustment:

   a. Lift the Generator Board Assembly, exposing the Master Board.

   b. Connect a Digital Voltmeter to the +12 Volt Test Point (Red).

   c. Adjust R20 until the reading is 12.000 Volts.

   d. Check the voltage at the -12 Volt Test Point. Should read 12.000 volts ±.2 volts.

   e. Lower the Generator Board Assembly into place.

2. Integrator Zero Adjustments:

   a. Short the F.C. input on the Front Panel.

   b. Connect the Digital Voltmeter to the Summing Junction of the Integrator. (Left end of .0022 Capacitor C25.)

   c. Adjust the INTEGRATOR ZERO Potentiometer for 0 volts DC at the Summing Junction.

   d. Disconnect the short from the F.C. input.

3. Square Wave Symmetry Adjustment:

   a. Position the Range Switch to X1K, and the Frequency Dial to 10.

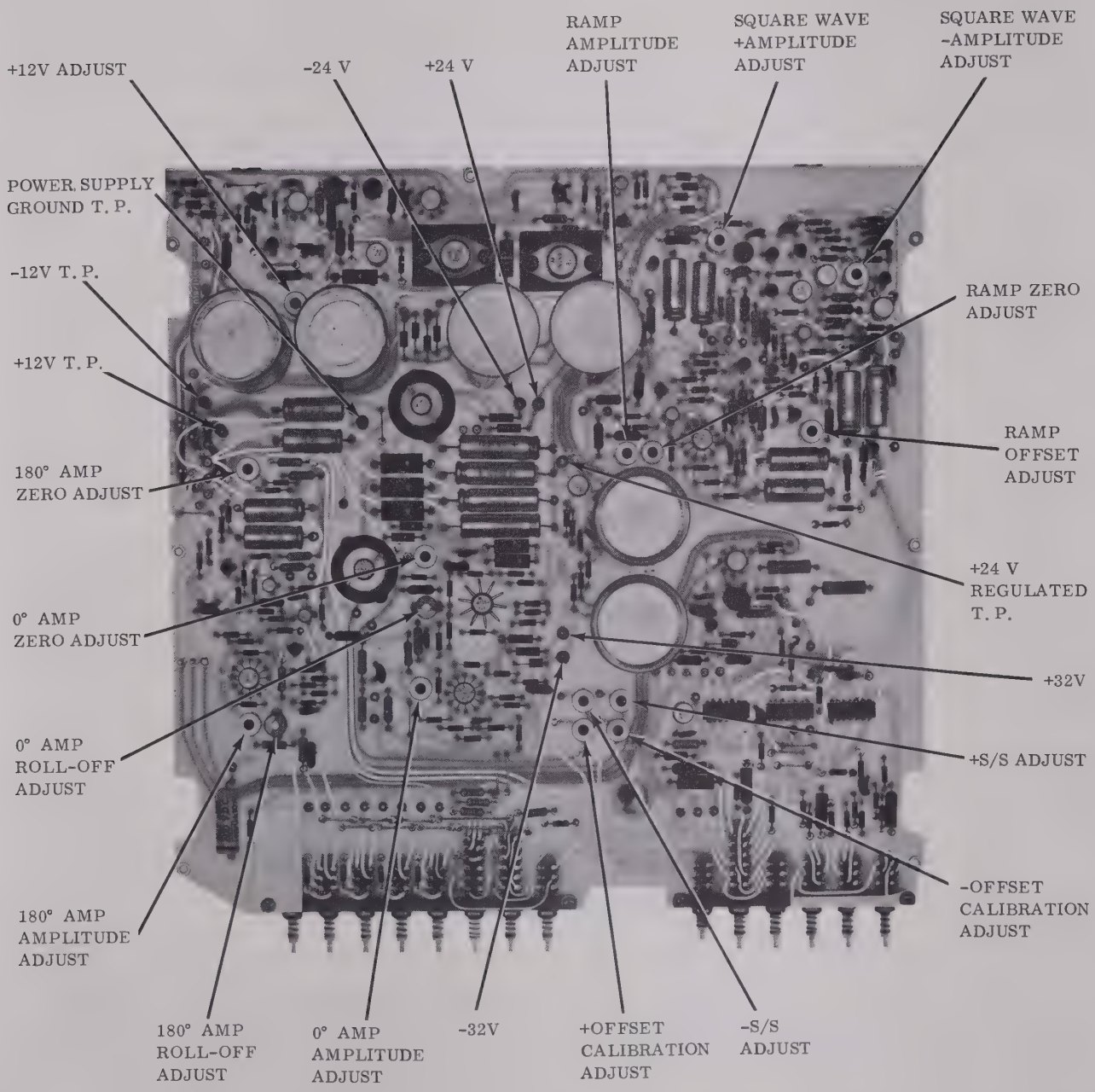


FIGURE 3-1

Master Board - Test Points
and Calibration Adjustments

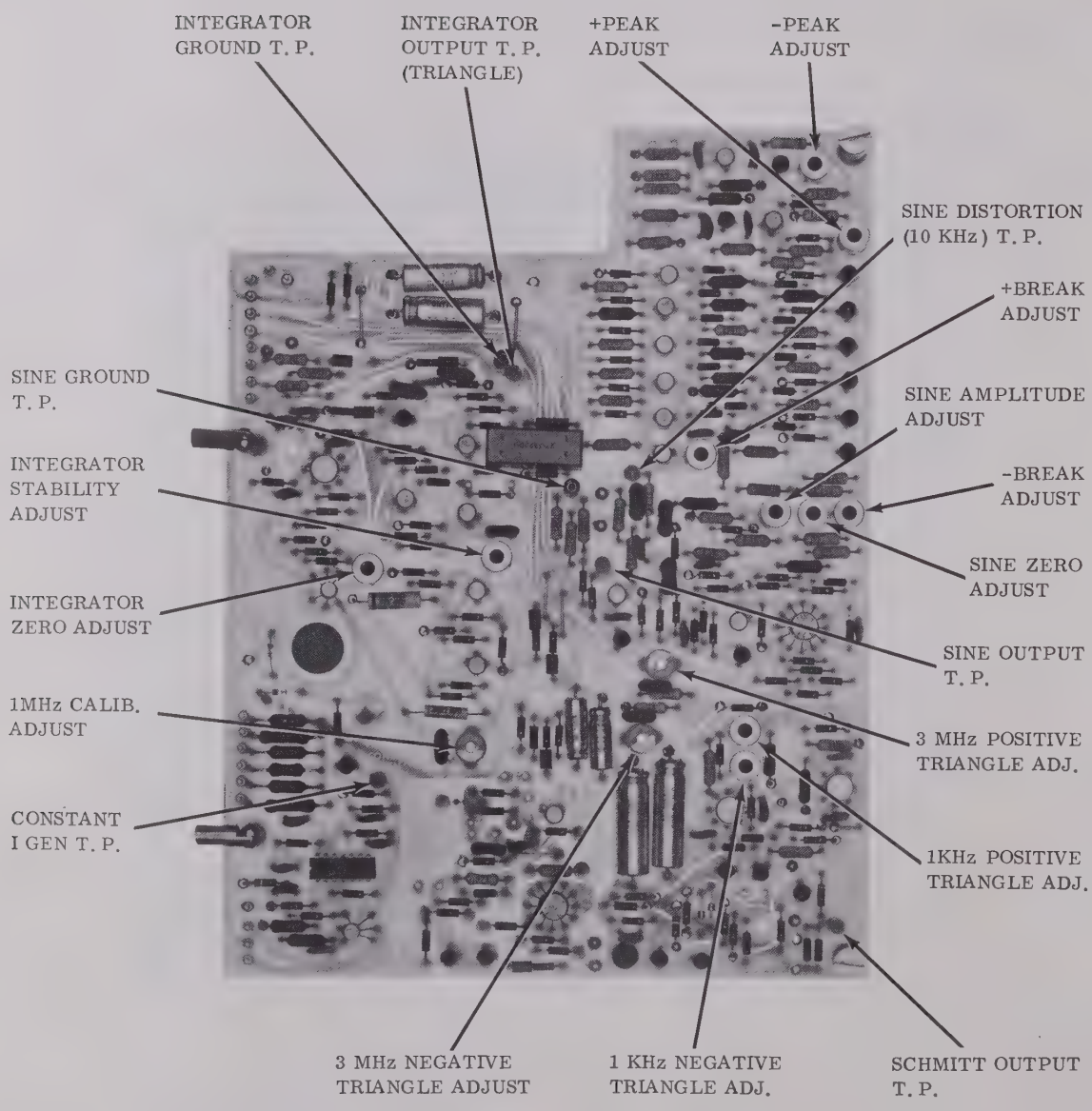


FIGURE 3-2

Generator Board - Test Points and Calibration Adjustments

b. Connect the Oscilloscope to the 50Ω output connector on the Front Panel. Terminate the output in a 50Ω load at the input to the Oscilloscope.

c. Select the Square Wave Function. Set Output Level to 0dB and the vernier fully clockwise.

d. Set Oscilloscope to - Trigger. Expand the sweep as far as possible, and adjust the Horizontal Position sc the positive going edge of the square wave is lined up with a vertical line on the grid.

See Fig. 3-3 on page 3-8

e. Switch the Oscilloscope to + Trigger and adjust the UPPER DIAL SYMMETRY Potentiometer so the negative going edge of the square wave lines up with the same vertical line on the grid.

f. Turn the Frequency Dial to 1.

g. Repeat Step d.

h. Switch the Oscilloscope to + Trigger and adjust the LOWER DIAL SYMMETRY Potentiometer so the negative going edge of the square wave lines up with the same vertical line on the grid.

i. Repeat Steps a. through g. until no further adjustment is required.

4. Schmitt Trigger Adjustments:

a. Connect the Oscilloscope to the Integrater Output Test Point (Green).

b. Adjust the TRIANGLE POSITIVE AMPLITUDE Potentiometer for + 1 volt peak amplitude.

c. Adjust the TRIANGLE NEGATIVE AMPLITUDE Potentiometer for - 1 volt peak amplitude.

d. Position the Range Switch to 100K and the Frequency Dial to 10.

e. Note Amplitude as displayed on the Oscilloscope.

f. Position the Range Multiplier Switch to X3.

g. Adjust the 3MHz POSITIVE TRIANGLE ADJUST for same amplitude as in step e.

h. Adjust the 3MHz NEGATIVE TRIANGLE ADJUST for same amplitude as in step e.

5. Sine Generator Adjustments:

a. Position the Range Switch to X1K, and the Frequency Dial to 10, and the Range Multiplier Switch to X1.

b. Connect the Oscilloscope to the Sine Distortion Test Point (Green).

c. Vary the Frequency Dial slightly for minimum amplitude at the test point.

d. Adjust the NEGATIVE BREAK Potentiometer for minimum signal.

e. Adjust the POSITIVE BREAK Potentiometer for minimum signal.

f. Adjust the NEGATIVE PEAK Potentiometer for minimum signal.

g. Adjust the POSITIVE PEAK Potentiometer for minimum signal.

h. Repeat Steps d. through h. until no further adjustment is required.

6. Output Amplifier Adjustments:

a. Connect the Oscilloscope to the 50Ω output connector on the Front Panel. Terminate the output in a 50Ω load at the input to the Oscilloscope.

b. Select the Triangle Function and raise the Generator Board Assembly.

c. Make sure the Output Attenuator is at 0dB and the Amplitude Control is fully clockwise.

d. Adjust the OUTPUT AMPLIFIER ZERO Potentiometer for equal peak amplitude above and below 0 volts DC.

e. Adjust the OUTPUT AMPLITUDE Potentiometer for 17 volts peak-to-peak amplitude.

f. Adjust the sensitivity of the Oscilloscope so the signal displayed is a full grid in amplitude.

g. Select the Square Wave Function, and adjust the POSITIVE and NEGATIVE AMPLITUDE Potentiometers for full grid deflection.

h. Select the Sine Wave Function, and lower the Generator Board Assembly into place.

i. Adjust the SINE ZERO Potentiometer for equal amplitude above and below 0 volts DC.

j. Adjust the SINE AMPLITUDE Potentiometer for full grid deflection.

k. Select the Ramp Function, and raise the Generator Board Assembly.

l. Adjust the RAMP ZERO Potentiometer so the base of the Ramp is at 0 volts DC.

m. Adjust the RAMP OFFSET Potentiometer so the start of the Ramp is at 0 volts DC.

n. Adjust the RAMP AMPLITUDE Potentiometer for full positive deflection.

o. Lower the Generator Board Assembly into place.

180° AMPLIFIER ADJUSTMENTS:

1. Position the Range Switch to X1K, and the Frequency Dial to 10.

2. Connect the Oscilloscope to the 50Ω output connector on the Front Panel. Terminate the output in a 50Ω load at the input to the oscilloscope.

3. Select the triangle Function and raise the Generator Board Assembly.

4. Make sure the Output Attenuator is at 0dB and the Amplitude Control is fully clockwise, and the 0° button is depressed.

5. Adjust the sensitivity of the Oscilloscope so the signal displayed is a full grid in amplitude.

6. Depress the 180° button.

7. Adjust the 180° AMPLITUDE POTENTIOMETER for full scale deflection.

8. Adjust the 180° ZERO POTENTIOMETER for equal amplitude above and below zero volts.

9. Position the Range Switch to X100K

10. Select the Square Wave Function.

11. Adjust the 180° ROLL-OFF CAPACITOR for the best looking waveform.

12. Position the Range Switch to X1K.

13. Depress the 0° button.

14. Repeat Step 11.

15. Depress the OFFSET button.

16. Adjust the +OFFSET POTENTIOMETER so the base line of the wave form is at 0 volts.

17. Depress the 180° button.

18. Adjust the -OFFSET POTENTIOMETER so the base line of the wave form is at 0 volts.

19. Release the OFFSET button.

20. Depress the 0° button.

21. Position the Range Switch to X1K.

START/STOP ADJUSTMENTS:

1. Select the Sine Function.

2. Select the Triggered Mode.

3. Position the Sweep Rate Control at 1K, Sweep Rate Vernier fully Clockwise.

4. Connect the output from the Monitor Output Connector on the rear panel to the Trig Input connector on the front panel.

5. Position the Start/Stop Control at its center.

6. Adjust the Trigger Level Control until an output signal of one cycle is obtained.

7. Position the Start/stop Control at its Clockwise Position.

8. Adjust the +S/S POTENTIOMETER so the start level coincides with the positive peak of the Sine Wave.

9. Position the Start/Stop Control at its Counter-clockwise position.

10. Adjust the -S/S POTENTIOMETER so the start level coincides with the negative peak of the Sine Wave.

Frequency Control Adjustments:

a. Position the Range Switch to X1K, and the Range Multiplier to X1.

b. Adjust the Frequency Dial until the counter indicates exactly 500 Hz.

c. Short the F.C. Input terminals.

d. If the frequency changes, as shown on the counter, adjust the F.C.ZERO Potentiometer while alternately opening and shorting the F.C. Input terminals, until the frequency no longer changes. Reset to 500 Hz.

e. Apply an exact +4.7500 volts to the F.C Input.

f. Adjust the F.C. CALIBRATION Potentiometer for a reading of 10.00 KHz.

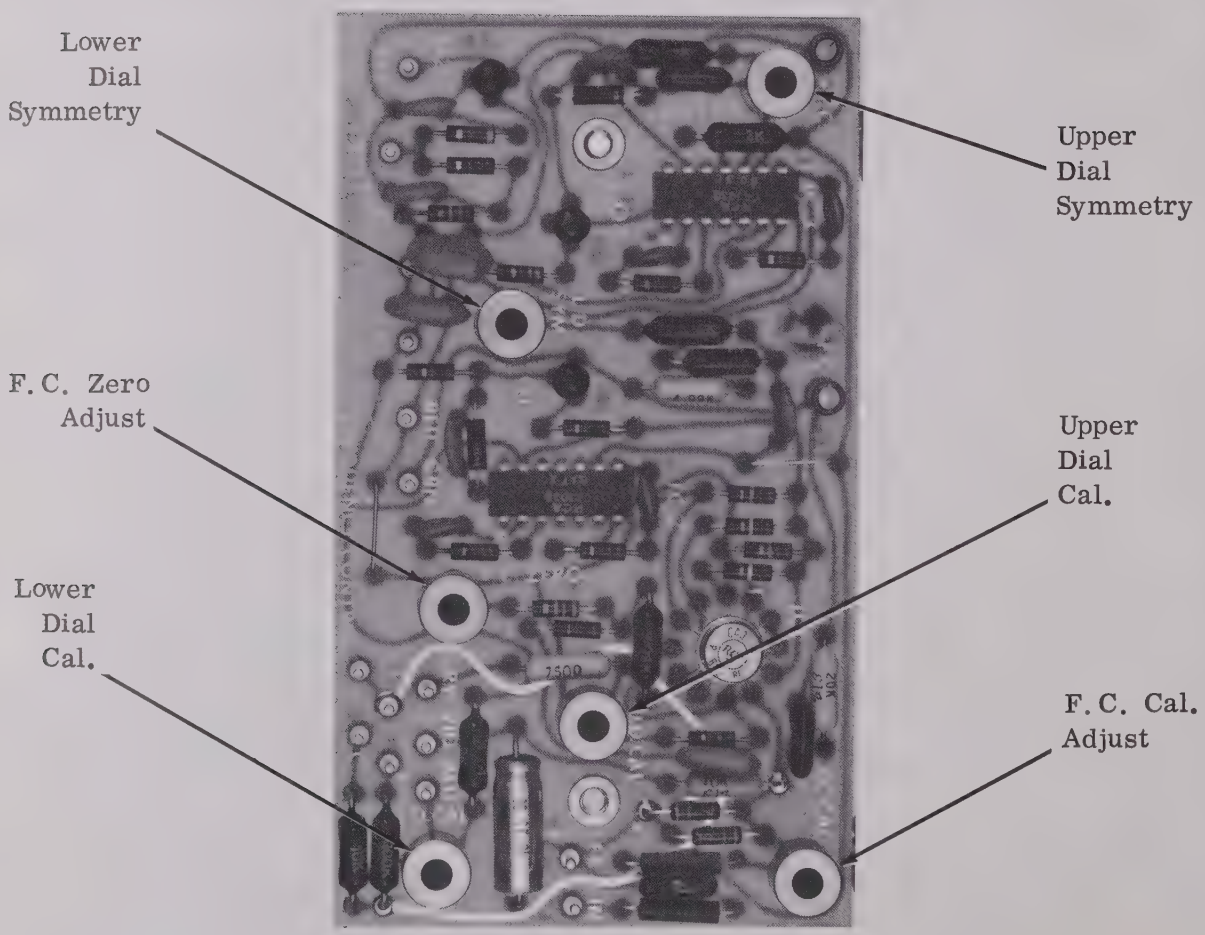


FIGURE 3-3
Frequency Control Board
Test Points and Calibration Adjustments

Frequency Calibration.

a. Select the Sine Function.

b. Position the Range Switch to X100, the Range Multiplier to X1, and the Frequency Dial to 0.5.

c. Connect the Frequency Counter to the 50Ω output connector on the Front Panel. Terminate the output in a 50Ω load at the input to the counter.

d. The counter should indicate 50 Hz ±1% of full scale.

e. Adjust the LOWER DIAL CALIBRATION Potentiometer for a reading of 50.00 Hz. (20.00 msec.).

f. Position the Frequency Dial to 10.

g. Adjust the UPPER DIAL CALIBRATION Potentiometer for a reading of 1.000 KHz.

h. Repeat step e to g as required.

i. Position the Range Switch to X1K, and raise the Generator Board Assembly

j. Adjust the variable capacitor on the Range Board (along the left side rail) for a reading of 10.00 KHz.

k. Lower the Generator Board Assembly, and position the Range Switch to X100K.

l. Adjust the variable capacitor in the center of the Generator Board for a reading of 1.000 MHz.

m. Check Step j. There is some interaction between these adjustments; if necessary repeat Step k. through m.

This completes the Frequency Calibration Procedure.

SWEEP CIRCUIT CALIBRATION:

1. A dual-trace Oscilloscope is needed for this portion of the procedure.

2. Position the Sweep Rate Switch in the X1K position, Vernier fully clockwise.

3. Select the Triggered Sweep Mode. (No Trigger Input applied).

4. Connect one channel of the Oscilloscope to the output of the Sawtooth Generator. (White/Red Quick-disconnect at right side of Generator board).

5. Connect the other channel to Pin #7 of I.C. 3.

6. Adjust the AMP ZERO POTENTIOMETER so the output is moving through zero volts. Observe that Pin #7 of I.C.3 changes state from +3 volts to 0 volts.

7. Adjust the SAW ZERO POTENTIOMETER so the output at Pin #7 of I.C. 3 change state, from +3 volts to 0 volts, when the output of the Sawtooth Generator is moving from positive to negative and when the output is between 10 mv and 15 mv.

8. Now adjust the AMP ZERO POTENTIOMETER so the output of the Sawtooth Generator is at 0 volts.

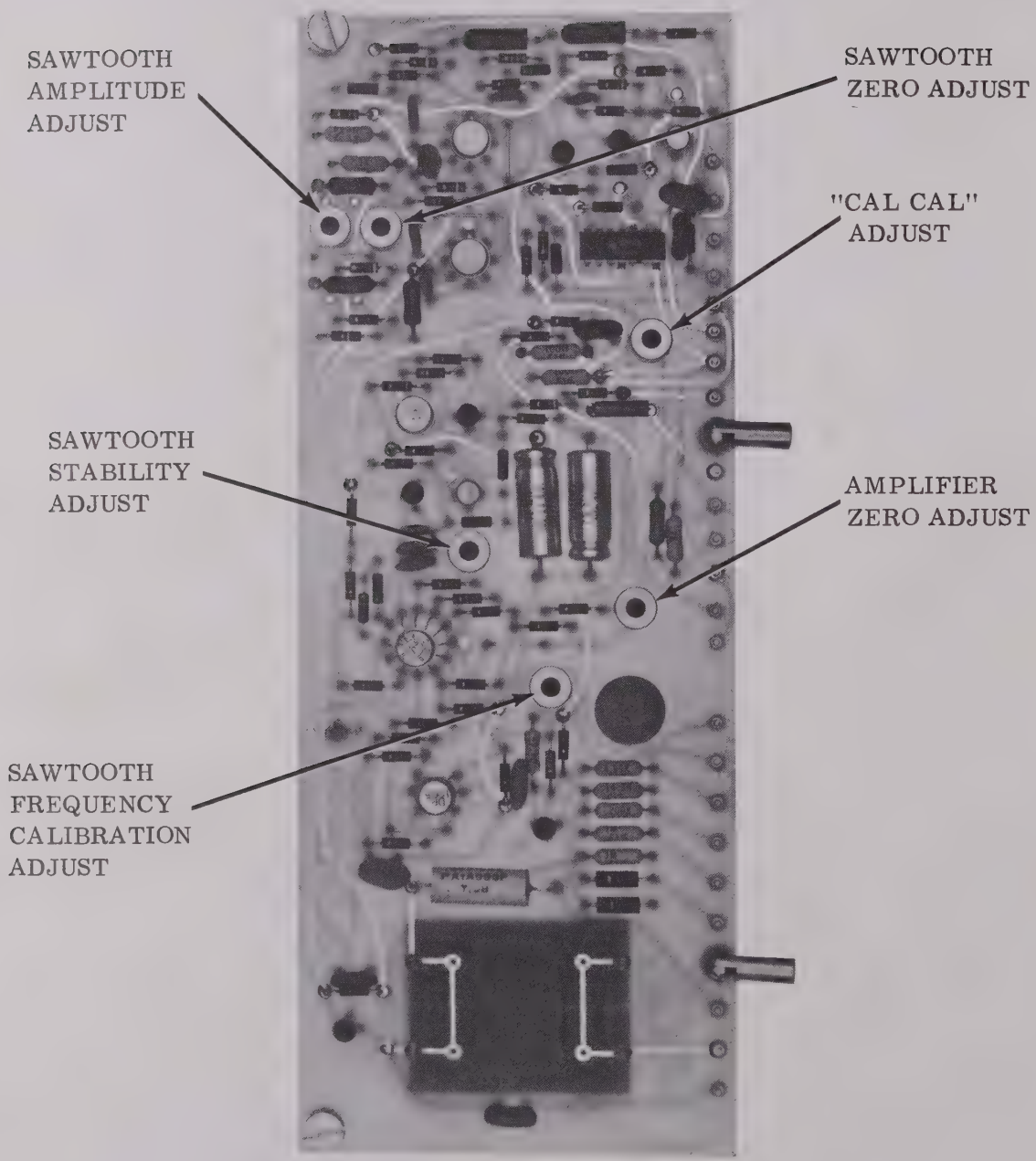


FIGURE 3-4
Sawtooth Generator Board
Test Points and Calibration Adjustments

CAL CAL ADJUSTMENTS:

1. Position Controls as follows:

a. Function	Sine
b. Range	X1K
c. Output	0°
d. Mode	Rep Sweep
e. Sweep Rate	1K
f. Vernier	Max
g. Calibrated Sweep Width	
Coarse	9
Fine	1.0

2. Connect a counter to the 50Ω Output connector on the front panel.

3. Position the "Sweep" Toggle Switch to the "Reset" position.

4. Adjust the Frequency Dial so the counter reads 100Hz, ±5%.

5. Position the "Sweep" Toggle Switch to the "Cal" position.

6. Adjust the CAL CAL POTENTIOMETER so the counter reads 10KHz ±0.25%.

SAWTOOTH AMPLITUDE ADJUSTMENTS:

1. Using a DVM, measure the voltage at the White/Grey Quick-disconnect at the right side of the Generator Board, and note the reading.

2. Using a differential or offset plug-in with the Oscilloscope, monitor the Sawtooth Generator output (white/red quick-disconnect).

3. Connect the DVM to the Monitor output jack on the Oscilloscope.

4. Adjust the SAW AMPL POTENTIOMETER until the Oscilloscope indicates a balanced condition, and the DVM indicates the same reading as in step 1 above.

SAWTOOTH STABILITY ADJUSTMENT:

1. Connect the Oscilloscope to the Monitor output connector on the rear panel.

2. Position the Sweep Rate Control to 100K, Vernier fully clockwise.

3. Adjust the SAW STAB POTENTIOMETER for good stability and a clean waveform.

SAWTOOTH CALIBRATION ADJUSTMENT:

1. Connect a counter to the Monitor Output connector on the rear panel.

2. Position the Sweep Rate Control to 10K, Vernier fully clockwise.

3. Adjust the SAW CAL POTENTIOMETER for a reading of 10KHz ±.5%

This completes the Calibration Procedure.

SPECIFICATION VALIDATION:

Prior to performing the specification validation, ensure that the operational and calibration adjustment procedures have been performed completely.

Before rejecting an instrument for inability to meet all specifications, be certain the test equipment specifications are equal to, or better than, those given in the list of required test equipment.

The following test equipment is required to validate the Model F230A specifications.

Electronic Counter, Hewlett-Packard, Model 5246L, or equivalent.

Time Interval Unit, Hewlett-Packard, Model 5262A, or equivalent.

Distortion Analyzer, Hewlett-Packard, Model 333A, or equivalent.

Distortion Meter, Boonton Electronics Corporation, Model 85B, or equivalent.

Oscilloscope, Tektronix, Model 547, or equivalent.

Differential Amplifier Plug-In, Tektronix, Model 1A5, or equivalent.

RMS-VTVM, Hewlett-Packard, Model 410C or equivalent.

Digital Multimeter, Cimron, Model 7650, or equivalent.

Strip Recorder, Clevite-Brush, Model Mark 220, or equivalent.

Frequency Range and Calibration Accuracy:

1. Interconnect the equipment as shown in Figure 3-3, observing signal and ground connections carefully.

2. Position F230A controls as follows:

a.	Function	Sine
b.	Frequency Range	X.01
c.	Range Multiplier	X1
d.	Frequency Dial	1
e.	Attenuator	0dB
f.	Amplitude	Mid-range
g.	Mode	Normal

3. Observe that the counter indicates a time interval of 100.0 seconds ±1% of full scale.

4. Position the Range Switch to X.1

5. Observe that the counter indicates a time interval of 10.00 seconds ±1% of full scale.

6. Position the Range Switch to X1.

7. Observe that the counter indicates a time interval of 1.000 second ±1% of full scale.

8. Position the Range Switch to X10.

9. Observe that the counter indicates a time interval of 100.0 msec ±1% of full scale.

10. Position the Range Switch to X100.

11. Observe that the counter indicates a time interval of 10.00 msec ±1% of full scale.

12. Position the Frequency Dial to 10.

13. Observe that the counter indicates a time interval of 1.000 msec ±1%.

14. Position the Range Switch to X10.

15. Observe that the counter indicates a time interval of 10.00 msec ±1%.

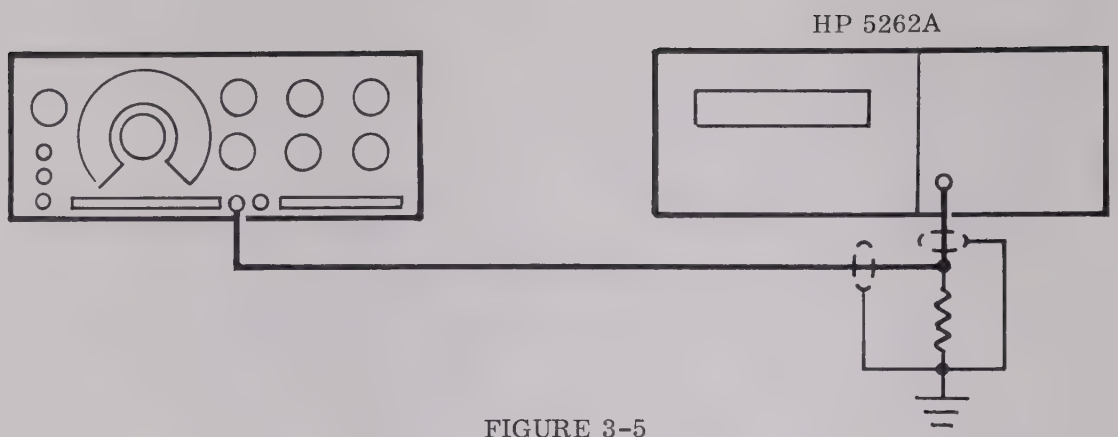


FIGURE 3-5

16. Position the Range Switch to X1.

17. Observe that the counter indicates a time interval of 100.0 msec ±1%.

18. Position the Range Switch to X.1

19. Observe that the counter indicates a time interval of 1.000 second ±1%.

20. Position the Range Switch to X.01.

21. Observe that the counter indicates a time interval of 10.00 seconds ±1%.

22. Position the Range Multiplier Switch to X3.

23. Observe that the counter indicates a time interval of 3.333 seconds ±1% of full scale.

24. Position the Range Switch to X.1

25. Observe that the counter indicates a time interval of 333.3 msec ±1% of full scale.

26. Position the Range Switch to X1.

27. Observe that the counter indicates a time interval of 33.33 msec ±1% of full scale.

28. Position the Range Switch to X10.

29. Observe that the counter indicates a time interval of 3.333 msec ±1% of full scale.

30. Interconnect the equipment as shown in Figure 3-4, observing signal and ground connections carefully.

31. Position the Range Switch to X100.

32. Position the Range Multiplier Switch to X1.

33. Observe that the counter indicates a frequency of 1.000 KHz ±1%.

34. Position the Range Switch to X1K.

35. Observe that the counter indicates a frequency of 10.00 KHz ±1%.

36. Position the Range Switch to X10K.

37. Observe that the counter indicates a frequency of 100.0 KHz ±1%.

38. Position the Range Switch to X100K.

39. Observe that the counter indicates a frequency of 1.000 MHz ±2%.

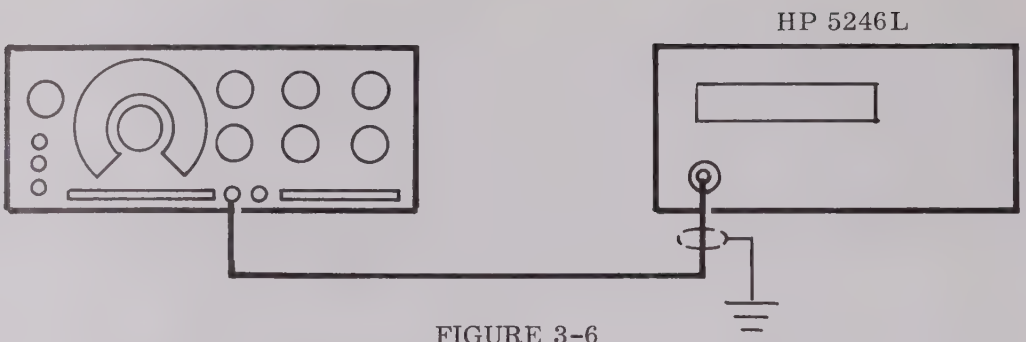


FIGURE 3-6

40. Position the Range Multiplier Switch to X3.

41. Observe that the counter indicates a frequency of 3.000 MHz ±2%.

42. Position the Range Switch to X10K.

43. Observe that the counter indicates a frequency of 300.0 KHz ±1%.

44. Position the Range Switch to X1K.

45. Observe that the counter indicates a frequency of 30.00 KHz ±1%.

46. Position the Range Switch to X100.

47. Observe that the counter indicates a frequency of 3.000 KHz ±1%.

48. Position the Range Multiplier Switch to X1.

49. Position the Frequency Dial to 1.

50. Observe that the counter indicates a frequency of 100.0 Hz ±1% of full scale.

51. Position the Range Switch to X1K.

52. Observe that the counter indicates a frequency of 1.000 KHz ±1% of full scale.

53. Position the Range Switch to X10K.

54. Observe that the counter indicates a frequency of 10.00 KHz ±1% of full scale.

55. Position the Range Switch to X100K.

56. Observe that the counter indicates a frequency of 100.0 KHz ±1% of full scale.

Frequency Response:

1. Position F230A controls as follows:

a.	Function	Sine
b.	Frequency Range	X1
c.	Range Multiplier	X1
d.	Frequency Dial	10
e.	Attenuator	0dB
f.	Amplitude	Mid-range
g.	Mode	Normal

2. Interconnect the equipment as shown in Figure 3-5, observing signal and ground connections carefully.

3. Adjust the Recorder for 95% deflection of the pen.

4. Position the Range Switch to X.1

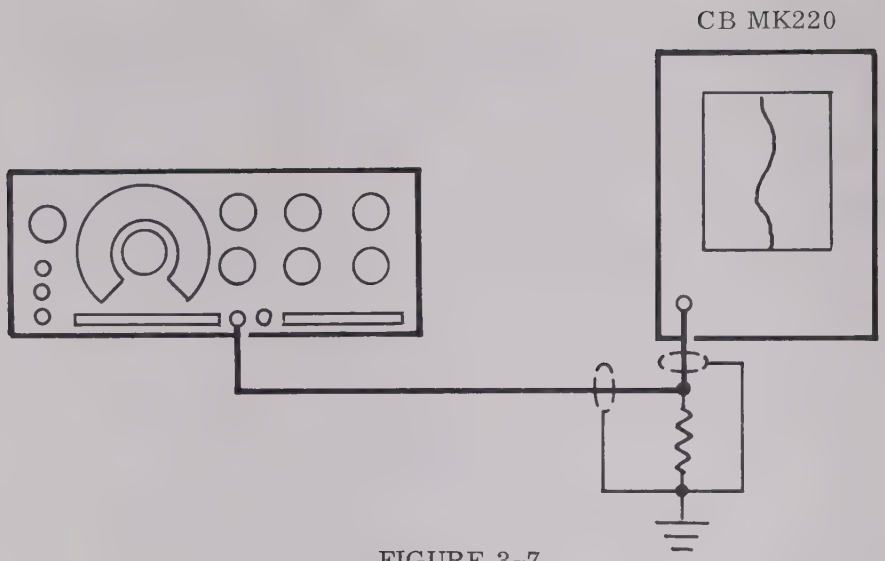


FIGURE 3-7

5. Observe that the amplitude is within .1dB.

6. Position the Range Switch to X.01.

7. Observe that the amplitude is within .1dB.

8. Position the Frequency Dial to 1.

9. Observe that the amplitude is within .1dB.

10. Position controls as in Step 1 above.

11. Interconnect the equipment as shown in Figure 3-6, observing signal and ground connections carefully.

12. Adjust the output of the Model F230A for an indication on the Digital Multimeter of 1.000 volts.

13. Position the Range Switch to X10.

14. Observe that the amplitude is within .1dB.

15. Position the Range Switch to X100.

16. Observe that the amplitude is within .1dB.

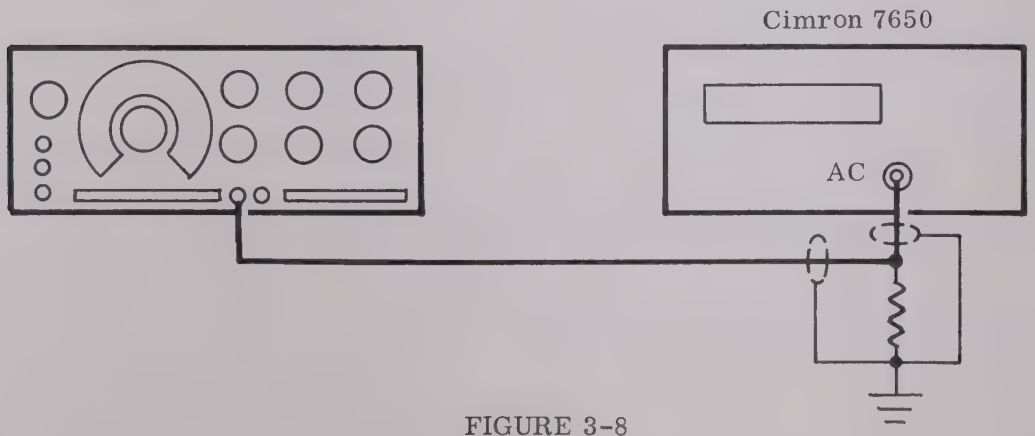


FIGURE 3-8

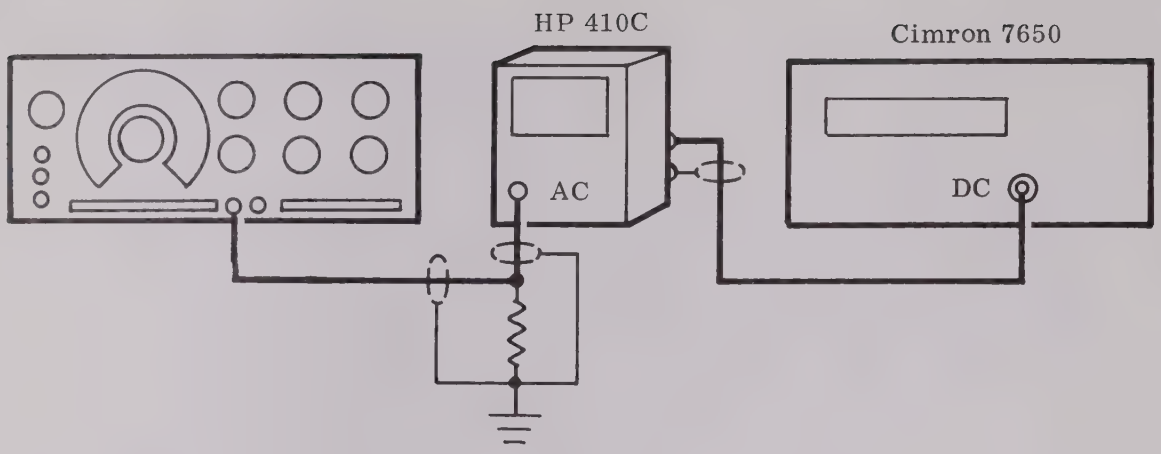


FIGURE 3-9

17. Position the Range Switch to X1K.

18. Observe that the amplitude is within .1dB.

19. Interconnect the equipment as shown in Figure 3-7, observing signal and ground connections carefully.

20. Adjust the output of the Model F230A for an indication on the Digital Multimeter of 1.000 volts.

21. Position the Range Switch to X10K.

22. Observe that the amplitude is within .1dB.

23. Position the Range Switch to X100K.

24. Observe that the amplitude is within .5dB.

25. Position the Range Multiplier Switch to X3.

26. Observe that the amplitude is within .5dB.

Distortion (Sine):

1. Position F230A controls as follows:

a.	Function	Sine
b.	Frequency Range	X1
c.	Range Multiplier	X1
d.	Frequency Dial	5
e.	Attenuator	0dB
f.	Amplitude	Clock-wise
g.	Mode	Normal

2. Interconnect the equipment as shown in Figure 3-8, observing signal and ground connections carefully.

3. Measure the distortion.

4. Observe that the distortion does not exceed 1%.

5. Position the Range Switch to X10.

6. Repeat Steps 3 and 4.

7. Position the Range Switch to X100.

8. Repeat Steps 3 and 4.

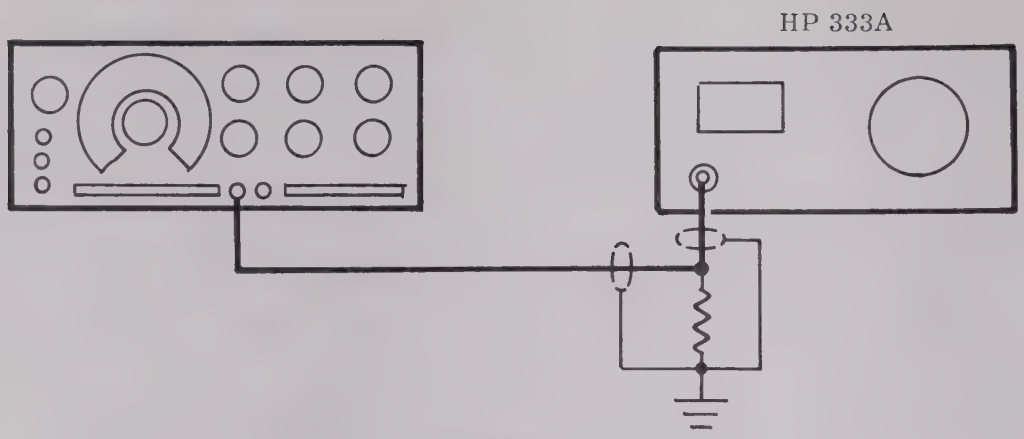


FIGURE 3-10

9. Position the Range Switch to X1K.

10. Repeat Steps 3 and 4.

11. Position the Range Switch to X10K.

12. Repeat Steps 3 and 4.

13. Position the Range Switch to X100K.

14. Measure the distortion.

15. Observe that the distortion does not exceed 2%.

16. Reduce the output amplitude of the F230A.

17. Interconnect the equipment as shown in Figure 3-9, observing signal and ground connections carefully.

18. Position the Frequency Dial to 10.

19. Measure the distortion.

20. Observe that the distortion does not exceed 5%.

21. Position the Range Multiplier Switch to X3.

22. Measure the distortion.

23. Observe that the distortion does not exceed 5%.

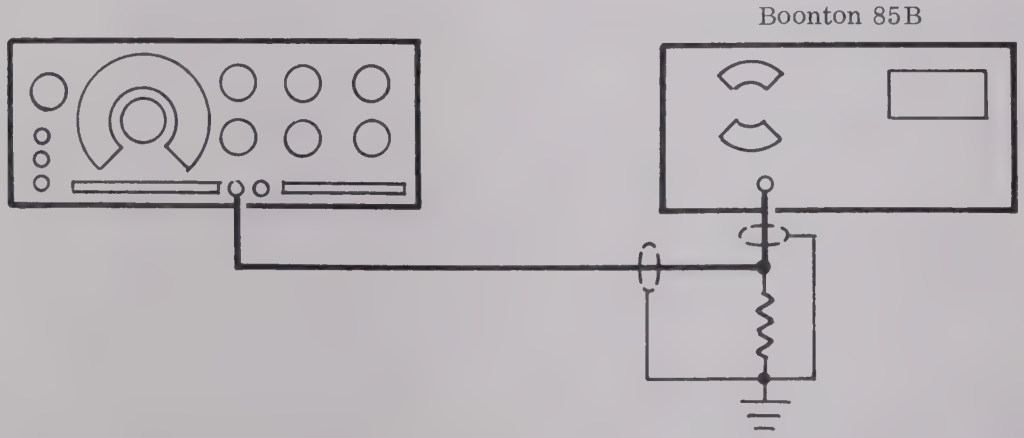


FIGURE 3-11

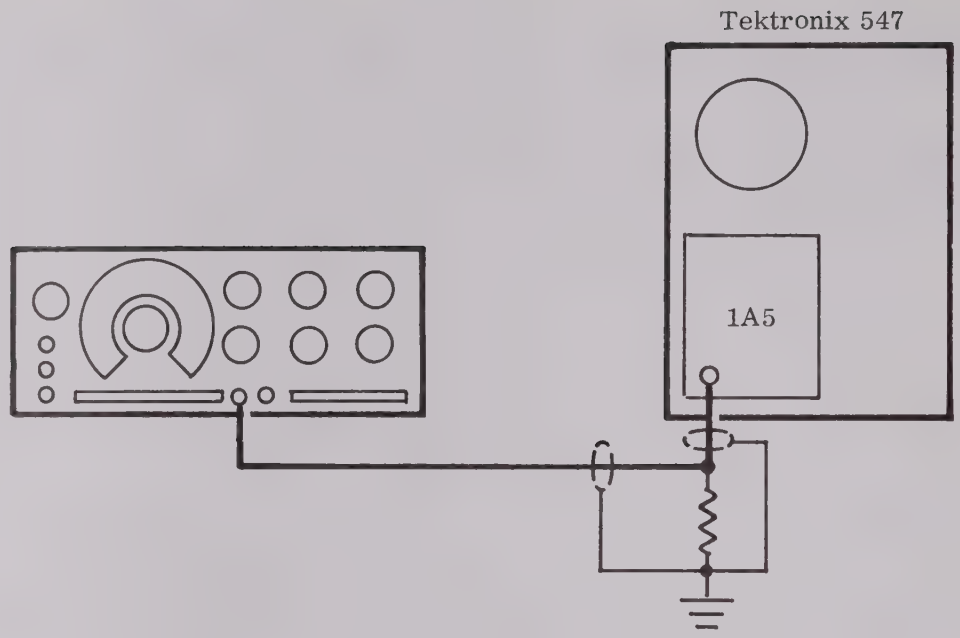


FIGURE 3-12

Rise and Fall Time:

1. Position F230A controls as follows:

a. Function	Square
b. Frequency Range	X10K
c. Range Multiplier	X1
d. Frequency Dial	10
e. Attenuator	0dB
f. Amplitude	Clock-wise
g. Mode	Normal

2. Interconnect the equipment as shown in Figure 3-10, observing signal and ground connections carefully.

3. Measure the Rise and Fall Time.

4. Observe that the Rise and Fall Time is less than 75 nsec.

5. Position the Range Switch to X100K.

6. Measure the Rise and Fall Time.

7. Observe that the Rise and Fall Time is less than 75 nsec.

8. Position the Range Multiplier Switch to X3.

9. Measure the Rise and Fall Time.

10. Observe that the Rise and Fall Time is less than 75 nsec.

Time Symmetry:

1. Position F230A controls as follows:

a. Function	Square
b. Frequency Range	X100K
c. Range Multiplier	X3
d. Frequency Dial	10
e. Attenuator	0dB
f. Amplitude	Clock-wise
g. Mode	Normal

2. Interconnect the equipment as shown in Figure 3-10, observing signal and ground connections carefully.

3. Measure the Time Symmetry.

4. Observe that the Time Symmetry is 95% or better.

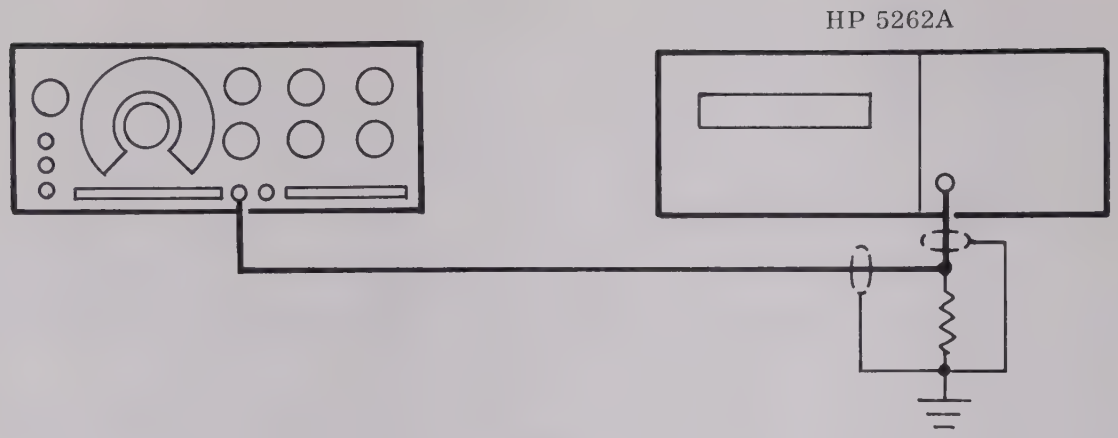


FIGURE 3-13

5. Position the Range Multiplier Switch to X1.
6. Measure the Time Symmetry.
7. Observe that the Time Symmetry is 99% or better.
8. Position the Range Switch to X10K.
9. Repeat Steps 5 and 6.
10. Position the Range Switch to X1K.
11. Measure the Time Symmetry.
12. Observe that the Time Symmetry is 99.5% or better.
13. Position the Range Switch to X100.
14. Repeat Steps 11 and 12.
15. Interconnect the equipment as shown in Figure 3-11, observing signal and ground connections carefully.
16. Position the Range Switch to X10.
17. Repeat Steps 11 and 12.
18. Position the Range Switch to X1.
19. Repeat Steps 11 and 12.
20. Position the Range Switch to X.1
21. Repeat Steps 11 and 12.
22. Position the Range Switch to X.01.
23. Repeat Steps 11 and 12.

Amplitude Symmetry, Overshoot, Preshoot and Tilt:

1. Position F230A controls as follows:

a.	Function	Triangle
b.	Frequency Range	X1K
c.	Range Multiplier	X1
d.	Frequency Dial	10
e.	Attenuator	0dB
f.	Amplitude	Clockwise
g.	Mode	Normal

2. Interconnect the equipment as shown in Figure 3-10, observing signal and ground connections carefully.
3. Select the 100 mv/cm range on the 1A5, and adjust the Reference Supply for 0 indication at the positive peak of the waveform.

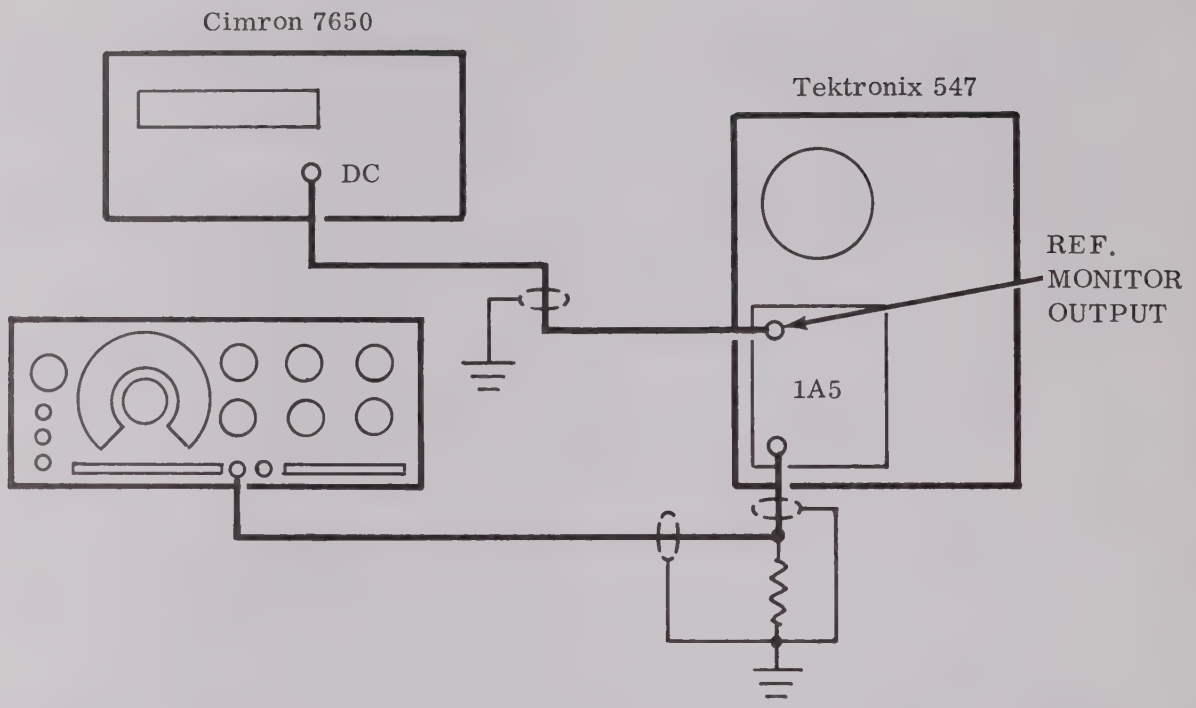


FIGURE 3-14

4. Switch the Reference Supply to -.

5. Observe that the negative peak is less than 1% of the peak-to-peak amplitude from the 0 line.

6. Select the Sine Function.

7. Repeat Steps 3 thru 5.

8. Select the Square Function.

9. Repeat Steps 3 thru 5.

10. Observe that the Overshoot and Preshoot do not exceed 5% of the maximum output of the F230A.

11. Observe that the Tilt does not exceed 0.5% of the maximum output of the F230A.

Triangle Wave and Ramp Linearity:

1. Position F230A controls as follows:

a.	Function	Triangle
b.	Frequency Range	X1K
c.	Range Multiplier	X1
d.	Frequency Dial	10
e.	Attenuator	0dB
f.	Amplitude	Clockwise
g.	Mode	Normal

2. Interconnect the equipment as shown in Figure 3-12, observing signal and ground connections carefully.

3. Adjust the Oscilloscope so the positive going half of the Triangle Wave takes up exactly the full horizontal grid.

4. Select the 100 mv/cm range on the 1A5, and adjust the Reference Supply for 0 indication at the start of the waveform.

5. Note and record the reading on the Digital Multimeter.

6. Increase the Reference Supply until the waveform intersects the next major vertical mark.

7. Repeat Steps 5 and 6 until the desired number of check points have been recorded.

8. Compute the actual linearity and observe that the linearity is 99% or better.

9. Position the Range Switch to X100K.

10. Repeat Steps 3 thru 7.

11. Compute the actual linearity and observe that the linearity is 95% or better.

12. Adjust the Oscilloscope so the negative going half of the Triangle Wave takes up exactly the full horizontal grid.

13. Repeat Steps 4 thru 11.

14. Select the Ramp Function.

15. Position the Range Switch to X1K.

16. Adjust the Oscilloscope so the Ramp takes up exactly the full horizontal grid.

17. Repeat Steps 4 thru 11.

This completes the Specification Validation.

SECTION IV

THEORY OF OPERATION

The Model F230A is basically a Waveform Generator, with some additional circuitry to enable the instrument to function as a sweep Generator, Pulse Generator and Tone Burst Generator.

For the sake of clarity, the instrument will be discussed in sections. As shown in the diagram below (Figure 4-1), the instrument can be broken down into two distinct sections. All above the dotted line will be referred as the Waveform Generator, and all below the dotted line will be discussed seperately.

In order to fully understand the operation of the F230A, it is essential that the Waveform Generator be understood completely, and therefore the additional circuitry will not be mentioned until after the entire section dealing with the Waveform Generator.

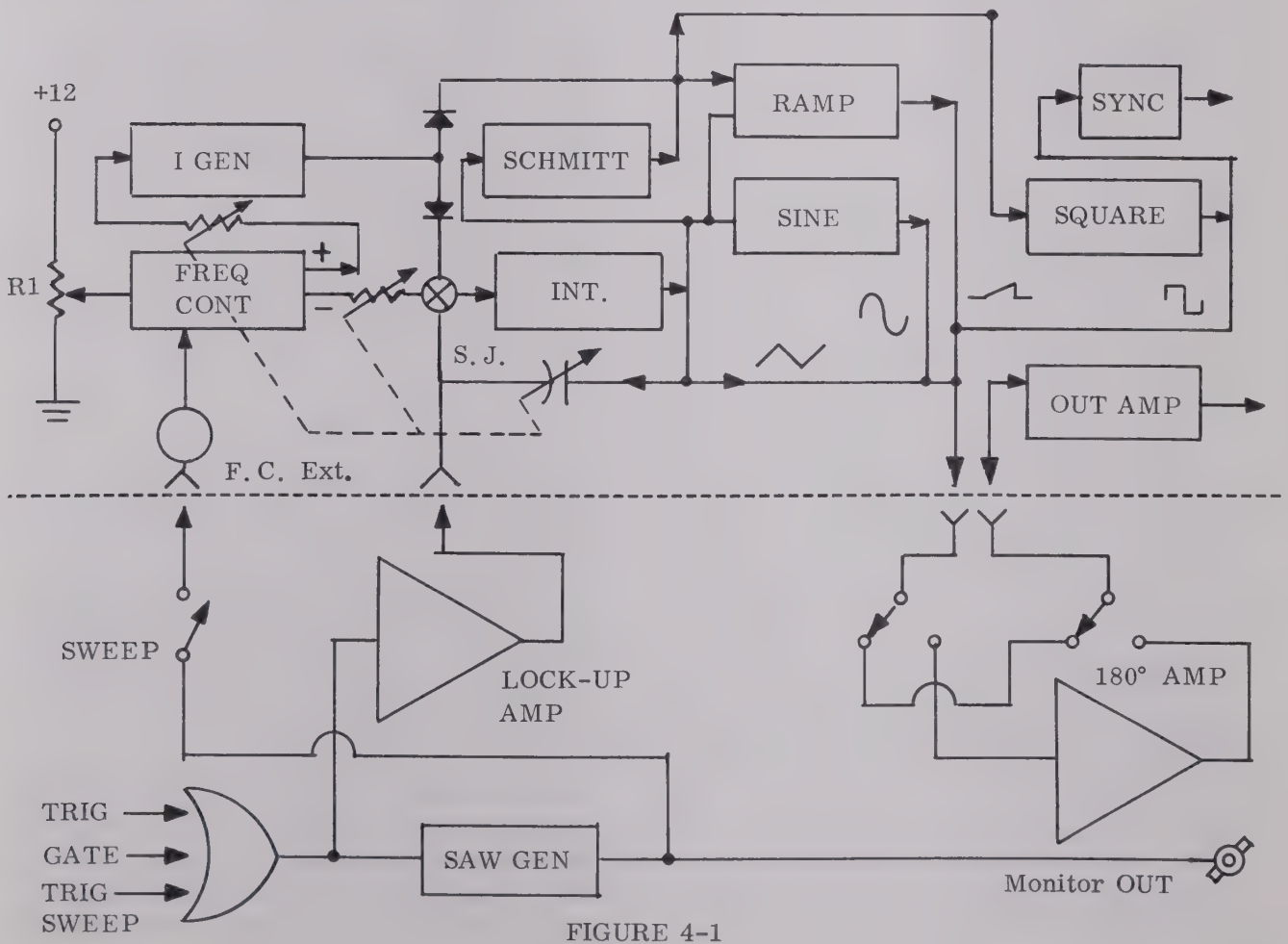


FIGURE 4-1

WAVEFORM GENERATOR

The generation of a triangular wave form is fundamental to all other wave forms in a waveform generator. It is generated as a function of the characteristics of a circuit referred to as an integrator.

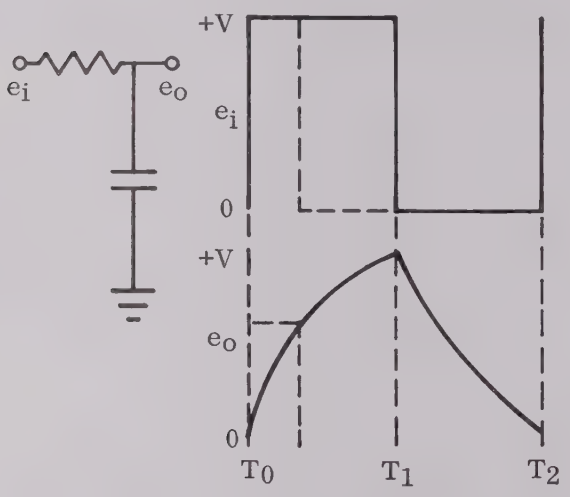


FIGURE 4-2

Figure 4-2 depicts a passive integrator. Assuming a step change in voltage to some positive value occurs at time T_0, the voltage drop across C_1 in the above circuit is equal to zero. As time T_1 approaches, the charge across C_1 increases and the voltage drop across R_1 decreased. In accordance with Ohm's law, the current through R_1 varies in direct proportion to the voltage across R_1. Therefore, as the charging rate of C_1 decreases, the current through R_1 also decreases. During the first increment of time the charging rate of C_1 is fairly linear.

The quality of integration improves as RC and/or frequency is increased. As illustrated in Figure 4-1, the linearity of E_0 is inversely proportional to the amount of E_0

In order to utilize this characteristic, the operational amplifier integrator of Fig. 4-3 is used.

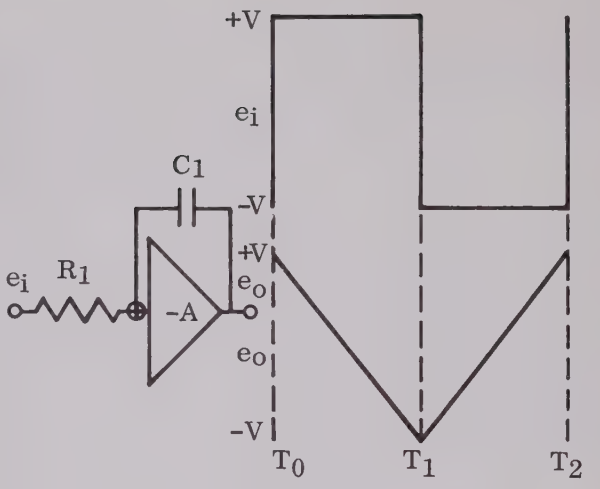


FIGURE 4-3

The rate of integration is approximately the same as the initial rate of integration of a passive integrator. However, the addition of an operational amplifier serves to maintain the charge of C_1 at a constant rate. In an operational amplifier the voltage appearing at the summing junction is equal to zero. Therefore, the voltage drop across R_1 is equal to the applied voltage, and the current through R_1 is constant. Assuming a perfect amplifier of infinite input resistance is used, the current through R_1 serves as the charging current for C_1. R_1 is usually a high precision, low temperature coefficient resistor.

For larger capacitor values, the integrating capacitor is usually made of poly--styrene or other very low leakage material. Amplifier gain should be high enough to assure that the summing junction is maintained as close to zero as practical; movement around zero results in non-linearities in the output voltage. On the other hand, extremely high gain should be avoided to assure proper stabilization.

Referring to Figure 4-3, it can be seen that the output voltage varies inversely as the integral of the applied voltage, the result of the phase inversion experienced in the amplifier. The triangle wave form is

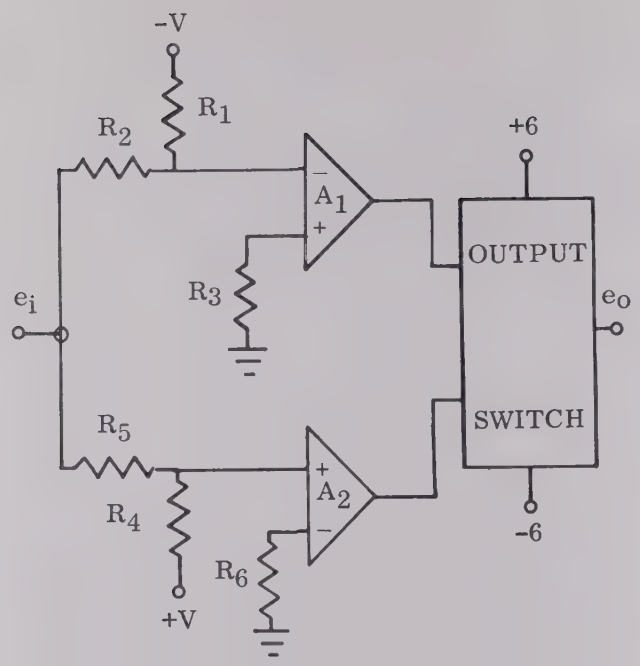


FIGURE 4-4

developed by switching the input voltage to an operational integrating amplifier between a positive and negative source of voltage.

Square wave generation is accomplished through the use of a level detector in conjunction with the triangle wave form from the integrator. A basic circuit is depicted in Figure 4-4.

In the circuit, A_1 and A_2 represent differential amplifiers having gains in excess of 1000. The typical output voltage swing is usually limited from 0 to +4 volts. With such a relationship, it can be seen that an input voltage change of more than 4mV will cause the output voltage to limit at 0 or +4 volts. It is this feature that is utilized in the level detector. The amplifiers are referenced through resistors R_3 and R_6 to ground, respectively. In one case the inverting (-) input is used and in the other the non-inverting (+) input. Resistors R_1 and R_4 establish bias levels at the input of each amplifier. As e_i increases from -1 to +1 volts, the voltage at the input of A_2 becomes more positive.

During the transition from -1 to +1 volts, the outputs of A_1 and A_2 are held positive. At time T_1, e_i reaches +1 volt and the voltage appearing at the inverting (-) input of A_1 becomes equal to 0 volts. The output of A_1 drops to 0 volts, where it remains until e_i reverses direction and begins to approach -1 volts. At time T_2 the procedure is reversed. The output voltage of A_2 drops to 0 volts during the period of time e_i equals -1 volt. The negative going pulses from the outputs of A_1 and A_2 are in turn used to switch a tunnel diode/transistor combination to produce a 12V p-p square wave with the phase relationship to the input waveform as illustrated in Figure 4-5.

It will be noted that the generation of the triangle wave form is the result of supplying

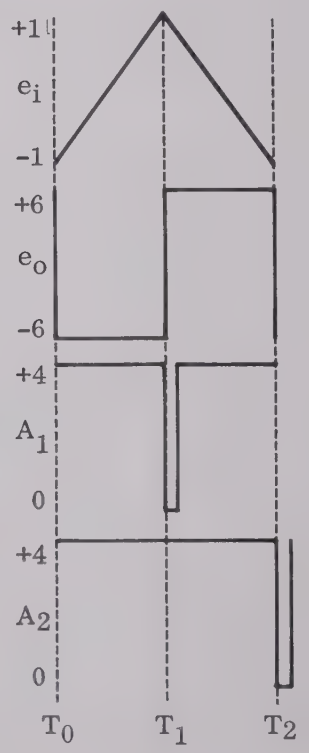


FIGURE 4-5

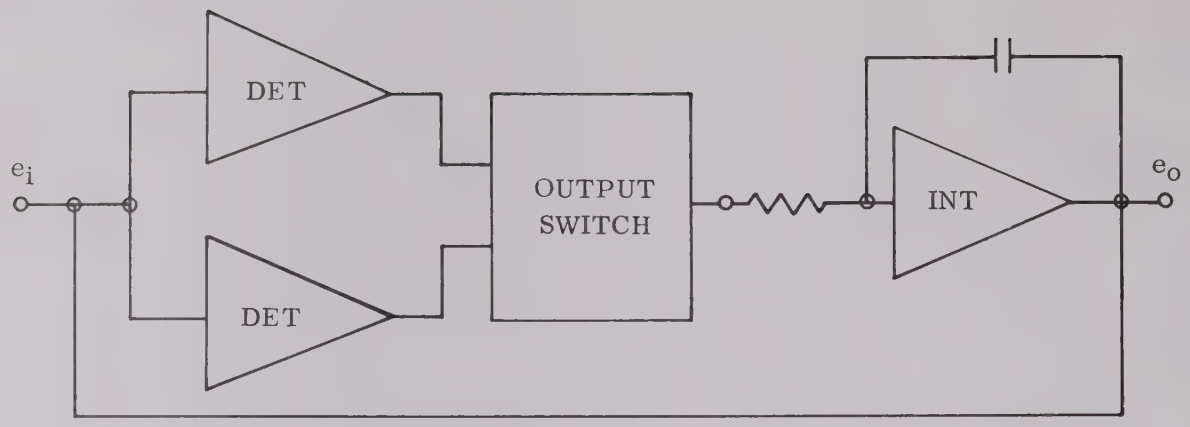


FIGURE 4-6

a square wave to the input of the integrating amplifier, Figure 4-6.

Aberrations at the top or bottom of the square wave effect the linearity of the triangle wave form since the rate of integration is dependent upon the amplitude of input signal. To remedy this situation, the square wave is used only to steer the charging current of the integrator to a constant current generator. The manner in which this is accomplished is depicted in Figure 4-7.

During the period of time input voltage e_i is at some positive value, diode CR_1 is reversed biased. Diode CR_2 is forward biased due to the polarity of the voltage appearing at the output of the voltage control amplifiers A_1 and A_2. The constant current generator maintains the current through R_1 at a value equal to twice the current through R_2. The additional current is supplied from the integrator, causing C_1 to discharge at a linear rate. During the period of time e_i is at some negative value, diode CR_1 is forward biased and CR_2 is reversed biased. current through R_1 is supplied from the input. C_1 charges at a rate determined by the current through R_2. Variations in the square wave amplitude are thus eliminated as a source of distortion.

The triangular wave form is synthesized into a sine wave by means of the circuit shown in Figure 4-8.

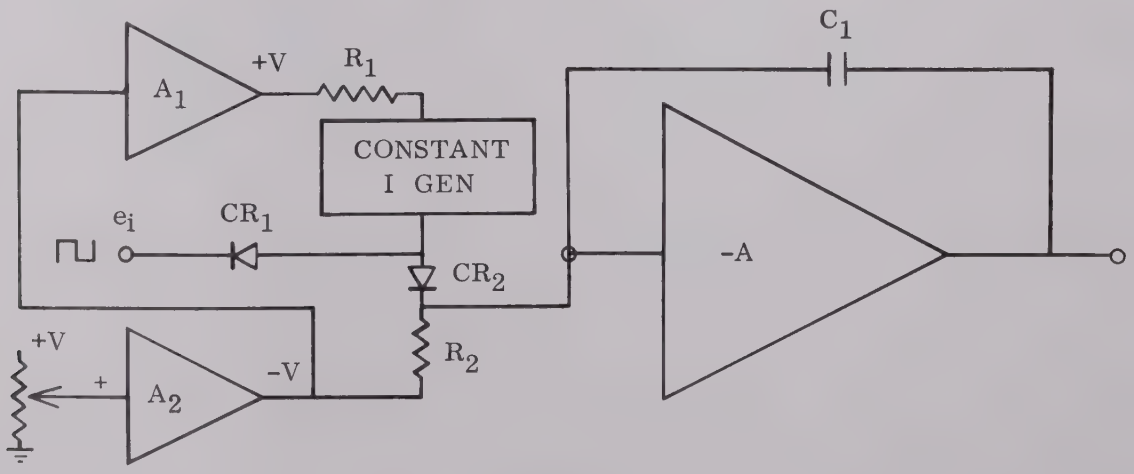


FIGURE 4-7

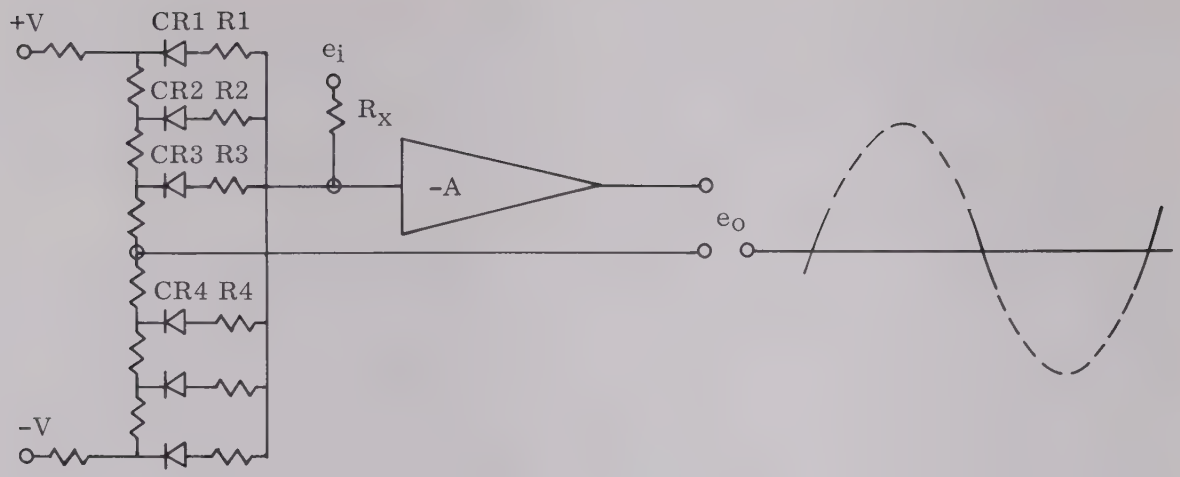


FIGURE 4-8

Diodes CR_1 CR_2 and CR_3 are biased at different levels as determined by their respective positions along a voltage divider. As the input voltage increases from 0 to some positive value of voltage the diodes CR_1 and CR_2 sequentially conduct. A voltage division occurs between R_X and the respective resistor associated with each diode which changes the slope of the voltage applied to the input of an amplifier. The sine wave output is approximated from a series of segments. The number of segments used determines the purity of the resulting wave form.

Figure 4-9 is a basic block diagram of the waveform generator which can be broken down into several sections.

a. The Generator, comprised of the Frequency Control Amplifiers, the Integrating Amplifier, the Schmitt Trigger, and a Constant Current Generator.

b. Shaping Amplifiers for the Sine, Square and Ramp Functions.

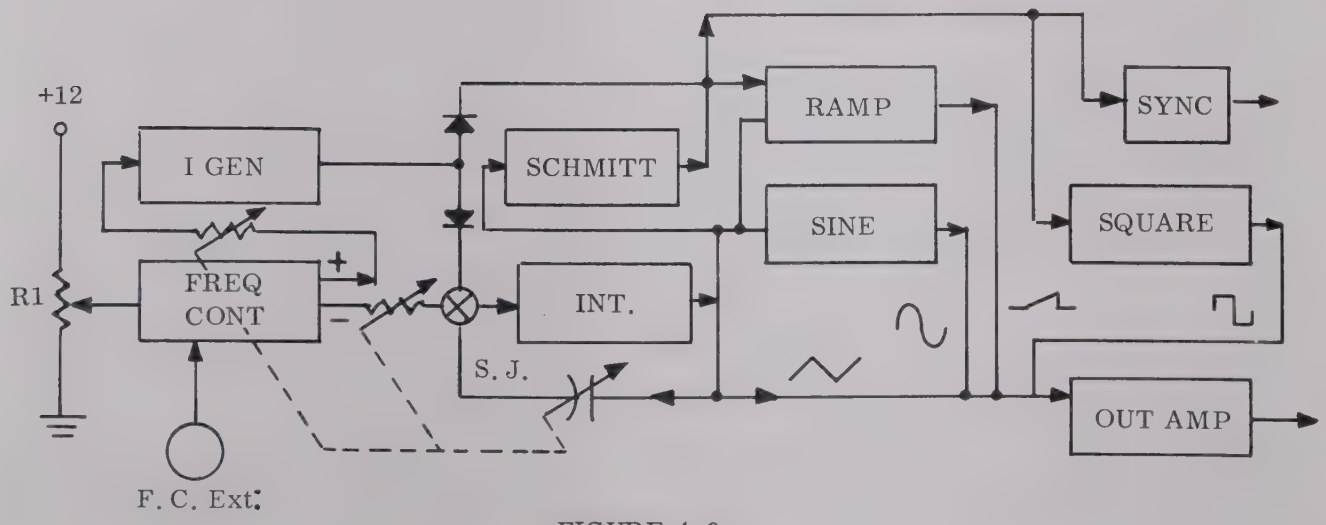


FIGURE 4-9

c. A separate amplifier provided to deliver a Sync signal.

d. The Output Amplifier, which is necessary to deliver the required output power, and the proper impedance matching.

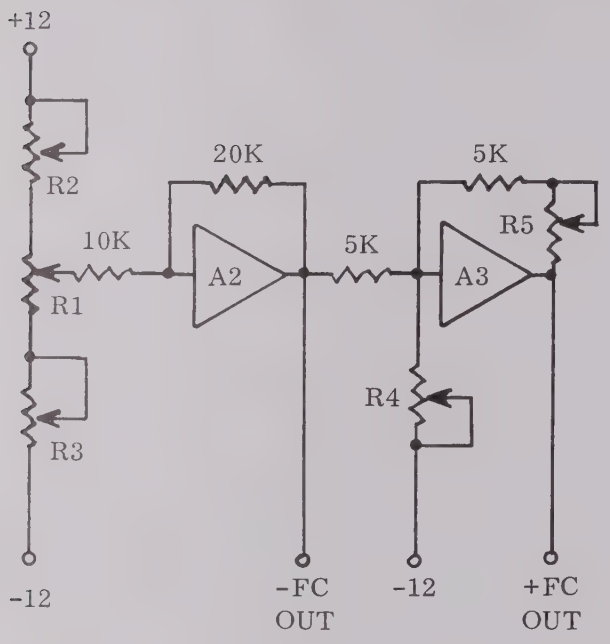


FIGURE 4-10

GENERATOR

Frequency Control Amplifiers:

The Frequency Control Amplifiers are essentially a pair of inverting DC amplifiers (Figure 4-10). The input signal is varied by R1, which is the Front Panel Frequency Control Potentiometer. This voltage is variable from +0.25 volts to +5 volts, therefore the output of A1 swings from -0.5 volts to -10 volts. The signal is also inverted through A3, giving a + voltage output from A3.

R2 is the UPPER DIAL CALIBRATION Adjustment, and simply determines the maximum positive voltage available at the top of the Frequency Control Potentiometer, and therefore the highest frequency. R3, likewise, determines the minimum voltage available at the bottom of the Frequency Control Potentiometer, and is the LOWER DIAL CALIBRATION Adjustment.

The output from A2 (-F.C.) swings from -0.5 volts to -10 volts, and is applied through a resistor to the Summing Junction of the Integrating Amplifier. The same signal is also applied to the input of A3. The input to A3, however, is offset by approximately -5 volts through R4, which is the LOWER DIAL SYMMETRY Adjustment.

R4 thus determines the minimum point of the + F.C. output from A3. The - F.C. output from A2 delivers a fixed amount of current to the Summing Junction during the half cycle when the integrating capacitor is charging. R4, therefore, is needed to ensure that the same amount of current is taken out of the Summing Junction during the half cycle when the integrating capacitor is discharging. R5 is the UPPER DIAL SYMMETRY Adjustment, and serves the same purpose at the maximum point of + F.C.

Schematic #6 (Section V) is the complete schematic of this circuit. The control voltage is applied through R9 to pin 9 of IC1, which is a pair of dual emitter followers, providing isolation between the control voltage source and the Frequency Control Amplifiers. The voltage level from IC1 is coupled into the inverting (-) input of IC2. The non-inverting (+) input of IC2 is referenced back to Ground through R13 and the other half of IC1. Pin 6 of IC1 might be called the differential input, and its DC level is determined by the FREQUENCY CONTROL ZERO Adjustment, R20.

The output from IC2 is coupled through CR3, which shifts the DC level of the signal to the proper operating point of Q1. Q1 is

an emitter follower supplying the required current for the - F.C. network. The output from Q1 is also taken back through R22 to the input, pin 9 of IC1. R22 is twice R9, therefore the overall gain of IC1, IC2 and Q1 is two.

IC3 gets its input from Q1, through approximately 5KΩ, R25, to the inverting (-) input, and the non-inverting (+) input is referenced back to Ground through R29. The output from IC3, through emitter follower Q3 and DC level shift diode CR4 is fed back to the input through approximately 5KΩ, R30 and R31. The input resistance equals the feedback resistance, therefore the gain of IC3 is unity. This output level is used to drive the +F.C. network. Q2 is the current source for CR4 and Q3.

Schmitt Trigger:

The Schmitt Trigger is essentially a level detector, with a few refinements to ensure a square wave output, whose rise time is extremely fast, see Figure 4-4. Because aberrations at the top and/or bottom of the square wave would affect the linearity of the triangle wave form from the Integrator, the chief concern is that the Schmitt Trigger deliver a pulse when its input reaches a predetermined level, and that the pulse has a fast rise time.

Schematic #2 (Section V) is the complete schematic of the Schmitt Trigger.

Assume a static condition of the circuit, when the outputs of both IC2 and IC3 are positive. IC2 being positive will hold Q4 in its cut-off state, and IC3 holds Q5 cut off. Q4 holds the emitter of Q7 at some voltage approaching the + supply. Q5 holds the base of Q7 at some voltage, determined by the voltage division of R33 and R34, but which is negative with respect to the emitter of Q7. A certain amount of current, therefore, is supplied by Q7 to the Tunnel Diodes, CR7 and CR8. Whether the tunnel diodes are in their "high" or "low" mode at this point can not be determined.

Now consider a triangle wave from the Integrator applied to the inverting (-) input of IC2. At some point of the positive going portion of the triangle, determined by the setting of R23, the signal will exceed the negative bias at pin 3, and the output of IC2 will go to its negative limit. This results in saturation of Q4, pulling its emitter to a negative level, also. Therefore the emitter of Q7 is also pulled more negative than its base. This results in Q7 being cut off, and no more current is supplied to the tunnel diodes. At this point the tunnel diodes will definitely switch to their low voltage state, or "low" mode.

As soon as the triangle wave starts on its negative going side, the drive is removed from IC2, and it will return to its original state, i.e. the output is positive. While this will ultimately turn Q7 on again, the amount of current supplied to the tunnel diodes is not sufficient to switch them to the "high" mode.

When the triangle wave reaches the negative peak and overcomes the reverse bias on IC3, the output of IC3 goes negative, pulling the base of Q5 negative, thereby turning Q5 on. This results in the emitter of Q5 going to the same negative level, supplying more base current to Q7. The current through Q7 increases and switches the tunnel diodes to their "high" mode.

Because of the tunnel diode action, Q8 acts effectively as a Flip-Flop. When the tunnel diodes are in their "low" mode, Q8 is cut off, and the output is positive. When the tunnel diodes are in their "high" mode, base current is supplied to Q8, and its output is negative.

The switching time of the tunnel diodes is on the order of nano-seconds, so that the square wave output from the Schmitt Trigger does have the fast rise time which is essential for linear integration.

Constant Current Generator:

Figure 4-11 shows the Constant Current Generator and the circuitry associated with the current switching to the Integrator.

IC4 is a standard differential amplifier, (See Schematic #3) whose output is 0 volts, as long as both inputs are equal. The non-inverting (+) input side is held constant at +5 volts by a simple voltage divider from the +12 volt supply. Q11 is a P-channel FET, which is biased so that it behaves as a variable resistor.

Assume that the voltage at + F.C. changes in a negative direction for some reason, This will result in a negative going signal at the inverting (-) input to IC4, and the output of IC4 will go in a positive direction. This decreases the conduction of Q11, effectively raising the resistance of Q11. The voltage division between R1 and Q11 is changed, raising the voltage at the inverting (-) input to IC4.

The square wave output from the Schmitt Trigger is fed into the cathode of CR1, thus when the input is at +6 volts CR1 is back-biased. R1 is 1/2 the resistance of R2, as noted in Figure 4-11. Therefore, regardless of the potential difference between + F.C. and - F.C. the current through R1 is always double the amount of current through R2. When CR1 is reverse biased, the Constant Current Generator maintains the current through R1 at a level equal to twice the current through R2.

The additional current, then, must be supplied from the Integrator, causing the integrating capacitor to discharge at a linear rate.

Similarly, when the input is at -6 volts, CR1 is forward biased, and therefore CR2 is reverse biased. The current through R1 is now supplied from the input, and the integrating capacitor charges at a rate determined by the current through R2.

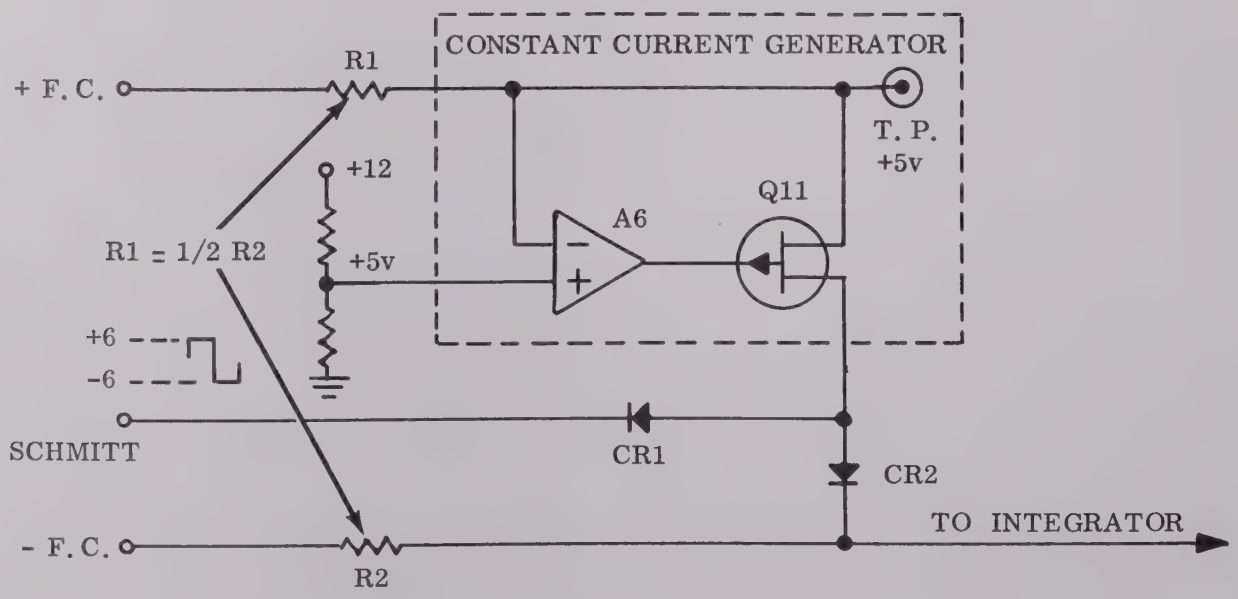


FIGURE 4-11

Referring now to Schematic #3, it will be seen that the resistance between Q11 and + F.C. is a varying value, depending on the range selected. (The resistors are selected by level "B" of the Range Switch, Schematic #15). For reasons of simplicity Q10 was not shown in Figure 4-11. Q10, however, is a source follower, providing a high impedance to the Current Generator, preventing any non-linearity due to loading.

Integrating Amplifier:

The introduction to this section covers the theory of integrating amplifiers. Figure 4-12 shows this particular amplifier in a little more detail. The amplifier is actually divided into two separate amplifiers, one a DC amplifier, which is active at the lower frequencies, and an AC amplifier, which takes over at higher frequencies. This is necessary because of the bandwidth of the F210A (.005Hz to 3MHz.).

C1 is the integrating capacitor. The fixed value shown is in the circuit at all times, while the switched value indicates different values being added on various ranges. This is done for reasons of ease of design, as it eliminates the necessity of using extremely large values of either resistance or capacitance.

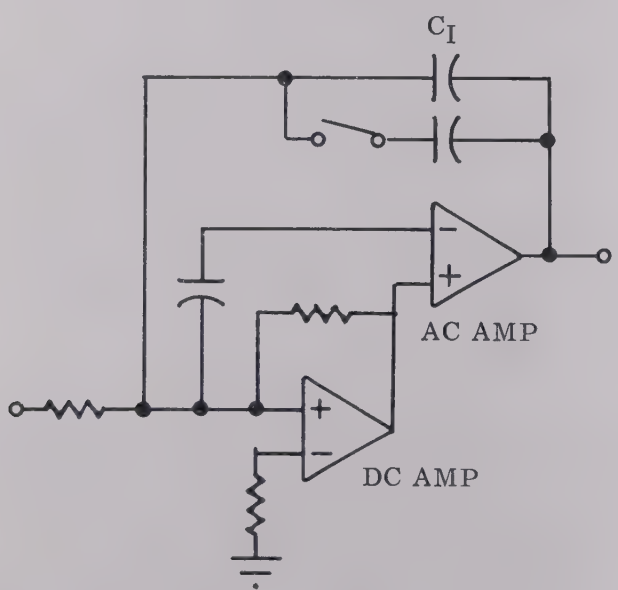


FIGURE 4-12

Referring to Schematic #4, Q12 and IC5 make up the DC amplifier, and the AC amplifier is comprised of Q13 through Q18. The dual-FET, Q12, serves as an impedance converter, and because of the differential input configuration, also serves as a means of stabilization of the amplifier.

The input to Q12 is in parallel with the input to Q13, and at some frequency, as determined by the values of C25 and R70, the input circuit to Q13 will present a lower impedance to the signal, and the AC amplifier takes over at this point.

SHAPING CIRCUITS

Sine Generator:

As shown in Figure 4-8, the Sine Generator is a synthesizing circuit, which has a triangle wave as its input. CR1 through CR_n are biased at different DC voltages, determined by their relative position along the voltage divider connected between the + and - power supplies.

Diodes CR1.....CR_n break down and conduct at increasing voltage levels as the triangle input increases from its negative peak to its positive peak. Therefore the slope of the input signal to the amplifier changes, causing the amplifier output to appear as a sine waveform.

Figure 4-13 shows a more detailed diagram of the Sine Generator.

For ease of drawing, the Sine Amplifier is shown as a simple differential amplifier. In theory the input signal to the non-inverting (+) input side is a sine wave. In pract-

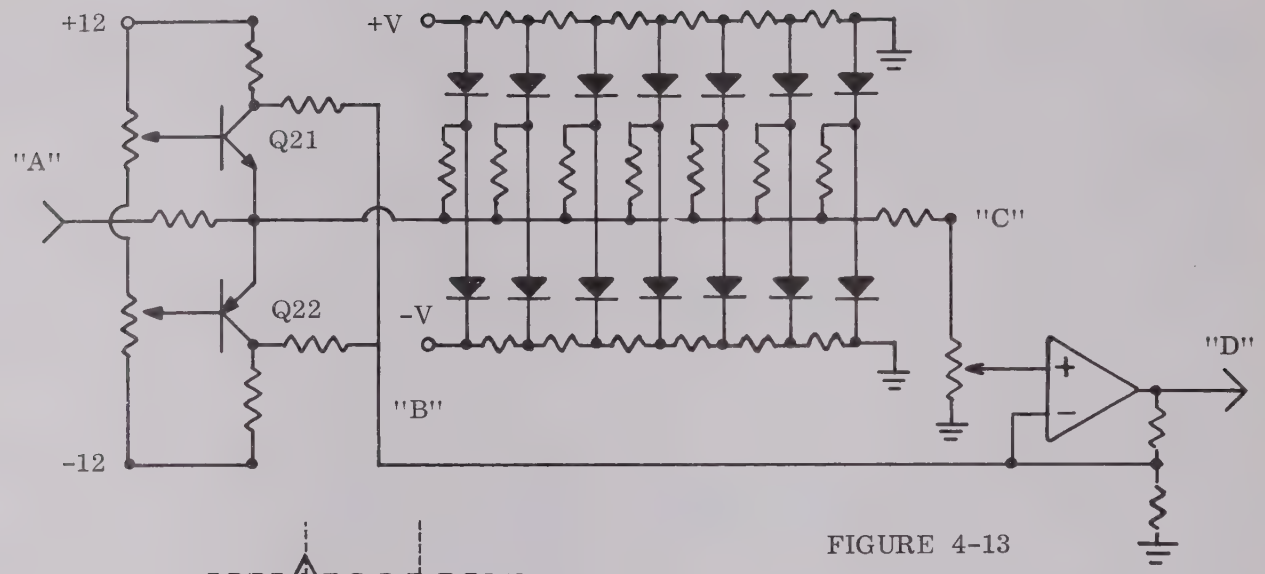
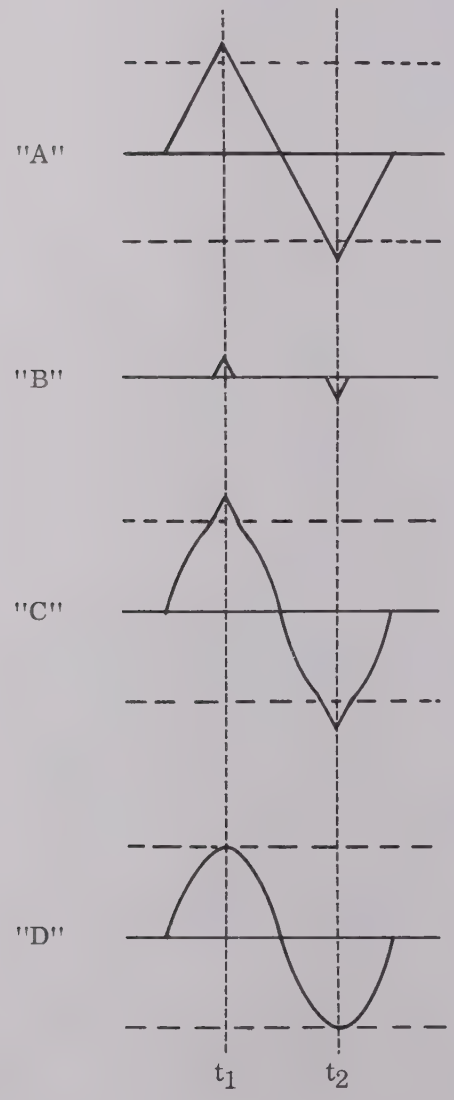


FIGURE 4-13



ice, however, the signal at point "C" contains a certain amount of peaking. Therefore the input triangle wave is applied to a pair of non-inverting (Common Base) amplifiers, Q21 and Q22. Q21 and Q22 are biased such that only the peaks of the triangle will cause them to conduct. The output signals from Q21 and Q22 are summed at point "B" and fed into the inverting (-) input side of the differential amplifier.

The input signal at point "C" is distorted by the amount of peaking riding on the sine wave, so by applying only the peaks to the inverting input, the net effect will be that of a subtracting circuit. The final output, thus will be a sine wave with little or no distortion remaining.

Schematic #5 is the complete schematic of the Sine Generator. Q19 and Q20 are the supplies for Q21 and Q22, respectively. As described above, R93 is the NEGATIVE PEAK Adjustment, and determines the point at which Q21 starts conducting. Likewise, R96 is the POSITIVE PEAK Adjustment.

Both sides of the synthesizing network are identical in operation, therefore only the positive side will be discussed. The bases of Q24, 26, 28, 30, 32 and 34 are held at some bias potential, determined by the POSITIVE BREAK Adjustment, R143. The arm of R143 is at +0.7 volts, typically, so the base of Q24 will be at approximately +0.35 volts. The emitters of all these transistors are returned to the -12 volt supply, so the transistors are always conducting. When Q24 is conducting, the voltage across the emitter-base junction is 0.7 volts, so the emitter of Q24 is at approximately -0.35 volts. The drop across CR20 is also 0.7 volts, therefore CR20 will start to conduct, when the input exceeds +0.35 volts. Similarly, CR22 conducts when the input level reaches +0.5 volts, and so on down the line, until at +0.7 volts CR31 conducts.

The Sine Amplifier is a differential amplifier. IC6 is connected in a differential pair configuration. Pin 6 is the signal input from the synthesizing network, while pin 9 is equivalent to the inverting input in Figure 4-13. Pin 9 receives the signal from the peak detectors, as discussed above. Pin 9 also accepts a portion of the output from the Sine Amplifier, so one half of IC6 serves as a stabilizing device, because the signal at pin 12 is degenerative (See below).

Following the signal from pin 6 of IC6, it will be seen that an inversion takes place in IC6. Another inversion occurs in Q36, thus the output signal from the Sine Amplifier is in phase with the input to pin 6. Q37 and Q38 is a pair of complimentary emitter followers. Q37 conducts on the positive half of the sine wave signal, and Q38 conducts on the negative half. The amplitude of the sine wave output is determined by the SINE AMPLITUDE Adjustment, R137, which divides the signal at CR30 for the desired output level.

The output signal is taken back to pin 9 of IC6, and an inversion takes place between pin 9 and pin 12. Considering only the signal from pin 12 of IC6, Q36 can be considered as a common-base amplifier, so no inversion takes place in Q36, therefore, the net result is that of degenerative feedback.

The SINE ZERO Adjustment, R147, varies the DC level at pin 9 of IC6, shifting the DC level of the output signal, to ensure that the output signal is symmetrical above and below 0 volts (Ground).

Square Wave Amplifier:

The Square Wave Amplifier accepts the ±6 volt square wave generated by the Schmitt Trigger. Referring to Schematic #8 the square wave is applied to the bases of Q8 and Q9. Assume a negative going signal at the base of Q8. Q8 is an emitter follower therefore the base of Q11 will be pulled in a negative direction, and Q11 will saturate.

Q10 is a series regulator, the voltage output of which is determined by the setting of the NEGATIVE AMPLITUDE Adjustment, R44. Thus, when Q11 saturates, its collector will rise to the maximum positive voltage available at the emitter. Q11 in turn drives an emitter follower, Q14, which provides the low output impedance and the current to drive the Output Amplifier.

Similarly, when the input square wave goes positive, Q12 saturates at the maximum negative voltage, as determined by the setting of the POSITIVE AMPLITUDE Adjustment, R47.

Ramp Generator:

The square wave signal at the emitters of Q8 and Q9 of the Square Wave Amplifier is also used as a gating signal for the Ramp Generator.

During the time the square wave signal is positive, the bases of Q17 and Q18 are held at approximately +0.7 volts by CR18 and CR19, respectively.

The triangle wave from the Integrator is applied to R58 and R59 and to the emitter of Q17. Because of the bias established by CR18, Q17 will remain cut off, as long as the signal at the emitter is more negative than 0 volts. R58, the RAMP OFFSET Adjustment, varies the voltage at the emitter of Q17 to 0 volts DC, so that the triangle input will be entirely negative.

Keeping in mind the phase relationship of the triangle and square wave (Figure 4-5) the triangle wave changes from its positive peak to its negative peak during the time the square wave is positive. Thus, the signal at the emitter of Q17 is a negative going ramp, the emitter returning to 0 volts DC instantaneously as the square wave gate signal goes negative. The negative level of the square wave is -6 volts and the triangle wave amplitude is on the order of 2 volts peak-to-peak, so the triangle voltage can never overcome the forward bias of Q17 as established by the negative half of the square wave. Therefore, during the transition of the triangle from its negative peak to its positive peak, the emitter of Q17 is effectively clamped to Ground.

Q18 serves essentially the same purpose as Q17, but provides more positive clamping of the ramp signal. Also, Q18 is not driven as hard as Q17, therefore, any transient pulses from the edges of the square wave are isolated from the Ramp Amplifier.

The Ramp Amplifier is identical in operation to the Sine Amplifier. As in the Sine Amplifier, IC3 is connected in a differential pair configuration with the incoming ramp signal applied to pin 6, and a portion of the output signal applied to the differential side, pin 3. The RAMP ZERO Adjustment, R74, determines the DC level of the output signal by varying the DC level at the differential input, pin 3. A portion of the output signal is taken back to pin 3, through the RAMP AMPLITUDE Adjustment, R80. The output signal from the Ramp Amplifier is a negative going ramp.

SYNC GENERATOR

The square wave signal at the emitters of Q8 and Q9 is used as the source signal for the Sync Generator.

The positive going edge of the square wave is differentiated through R33 and C25 and this pulse is applied to the base of Q16. Q16 provides a -10 volt pulse with a maximum duration of 5 μseconds, coincident with the leading edge of the square wave output.

OUTPUT AMPLIFIER

The Output Amplifier is also very nearly identical to the Sine Amplifier. The difference being that the Output Amplifier is an inverting amplifier, with part of the output signal taken back to the input, rather than to the differential side of an input pair. The OUTPUT ZERO Adjustment, R104, varies the DC level of the low side of the signal received from the Integrator and the Shaping Amplifiers. The low side of these signals is fed into the differential side of the input stage, IC4, in turn enabling the output signal to be varied around 0 volts DC, in order to achieve amplitude symmetry.

180° AMPLIFIER

The 180° Amplifier is identical in operation to the Output Amplifier. It is a bit different, physically, because it is not required to deliver power. When the 180° push button is depressed, the 180° Amplifier is inserted between the various shaping cir-

cuits and the Output Amplifier.

PUSH BUTTON CIRCUITS

Figure 4-14 is a simplified diagram of the Push Button Circuits for the various modes of operation. For reason of simplicity only the signal switching is shown. The ground also gets switched (See Schematic # 10).

The Function Switches are shown in the normally open positions. The Function and Power Switches are "latching" type switches, and therefore only one of the five can be activated at any given time.

The 0° and the 180° Switches are also "latching" type, thus one or the other will always be activated.

In Normal operation one of the Function Switches is depressed, and also the 0° push button. The signal flow is then from the shaping circuit through a closed contact on the 0° Switch, and through two sets of con-

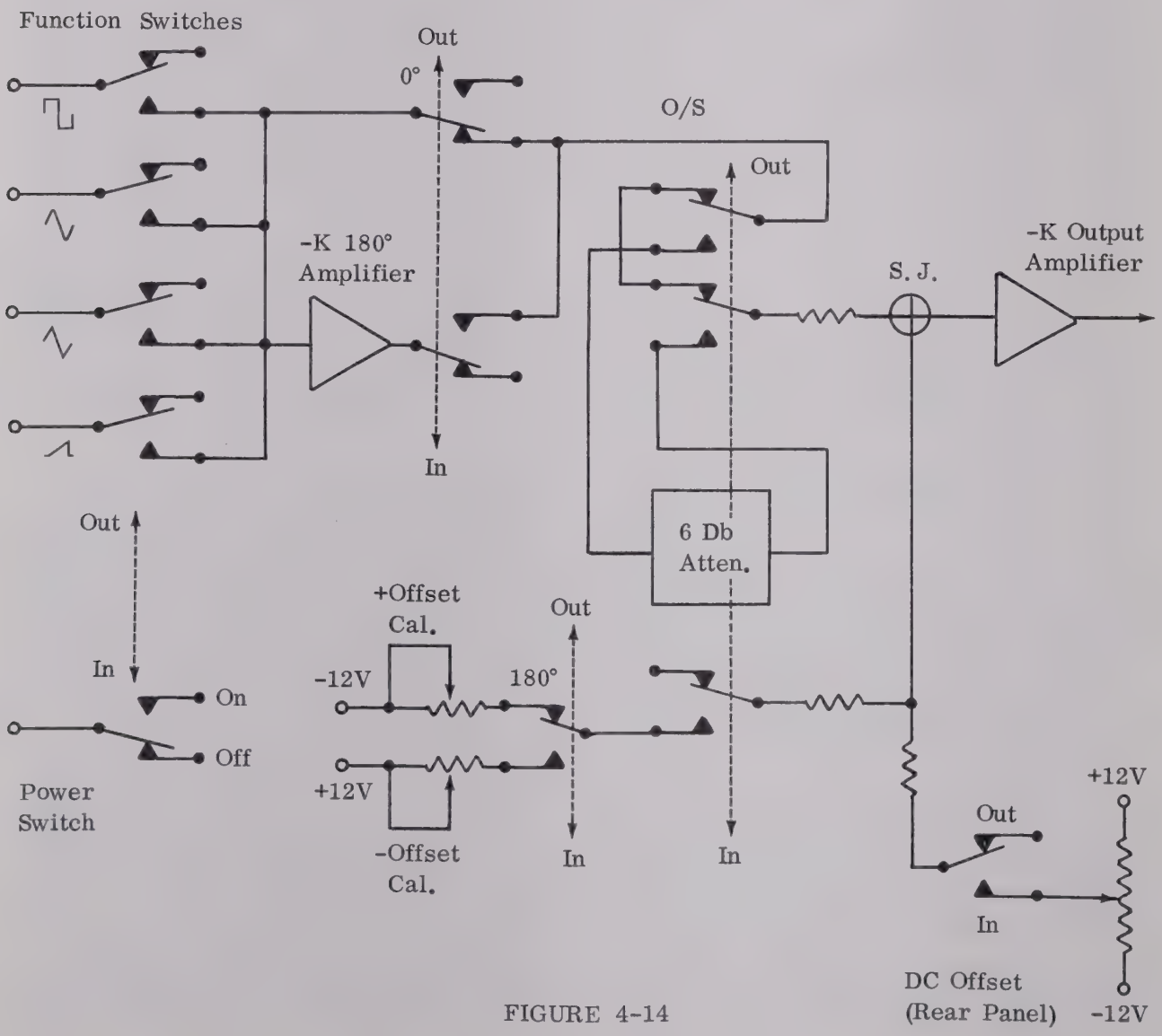


FIGURE 4-14

tacts of the O/S (Offset) Switch into the Summing Junction of the Output Amplifier. Note that the 180° Amplifier is always connected to the outputs of the shaping circuits.

If an inverted output signal is desired, the 180° push button is depressed, which un-latches the 0° button, and the 180° Amplifier is inserted between the Function Switches and the Output Amplifier.

The O/S Switch steers the signal into an attenuator (-6dB), which cuts the signal into the Output Amplifier in half. A third contact on the O/S Switch connects current from either the +12 volt or the -12 volt supply into the Summing Junction of the Output Amplifier. In the 0° mode current from the -12 volt supply is supplied to the Summing Junction, and the +Offset Calibration Potentiometer can now be adjusted so that the negative peak of the output signal is at 0 volts DC. The entire output signal is now above 0 volts, and true pulses are generated. (Keep in mind that the Output Amplifier is an inverting amplifier, thus any negative current introduced into the Summing Junction results in a positive offset at the output of the amplifier).

When an output is desired, where the entire signal is offset from 0 volts, the O/S Switch is depressed, and the DC OFFSET Switch on the Rear Panel is activated. This now allows additional current to be introduced into the Summing Junction of the Output Amplifier. The amount of current is determined by the setting of the DC Offset Control on the Rear Panel.

TRIGGER CIRCUITS

Figure 4-15 is a logic diagram representation of the controlling functions in the Gate, Trigger and Manual modes.

All gates shown are NAND gates, thus when all inputs to any one gate are positive, the output will be zero volts. When any one input is zero or negative, the output will be positive.

Gate #1: Two of the inputs to this gate are always connected to the +5 volt supply, thus this gate works as a simple inverter. That is, when the output from the Trigger Amplifier is +, the output of Gate 1 is at 0 volts. When the output from the Trigger Amplifier is -, the output of Gate 1 is at +4 volts.

Gates #2 and #3: These gates are interconnected as a Mono-stable Multivibrator. Assume that all inputs to Gate 2 are +. Therefore, the output of Gate 2 will be zero, and the output of Gate 3 will be +, holding Gate 2 on. The multivibrator will change state when any one of the inputs is driven negative, and it will stay until the RC combination between 2 and 3 has discharged.

The input signal to Gate 2 is the differentiated negative going edge from the Trigger Amplifier or from the Inverter, which depends on the position of the Trigger Slope Switch. This pulse is on the order of nano-seconds; but long enough to cause Gate 2 to open, raising its output to a + level.

This causes the output of Gate 3 to go to zero, thus locking Gate 2. After a certain time the RC circuit has discharged to the point where the input to Gate 3 is at zero, and the output from Gate 3 now returns to its + level, returning Gate 2 to its original condition. The result is a pulse of approximately 100 nano-seconds duration each time the Trigger Amplifier changes state.

Depressing the Manual Switch grounds one end of C1, thus also grounding one input to Gate 2, and the multivibrator changes state, and goes through the cycle as above.

Gate #4: One of the inputs to this gate is always returned to the +5 volt supply. One other gate is connected to the output of the

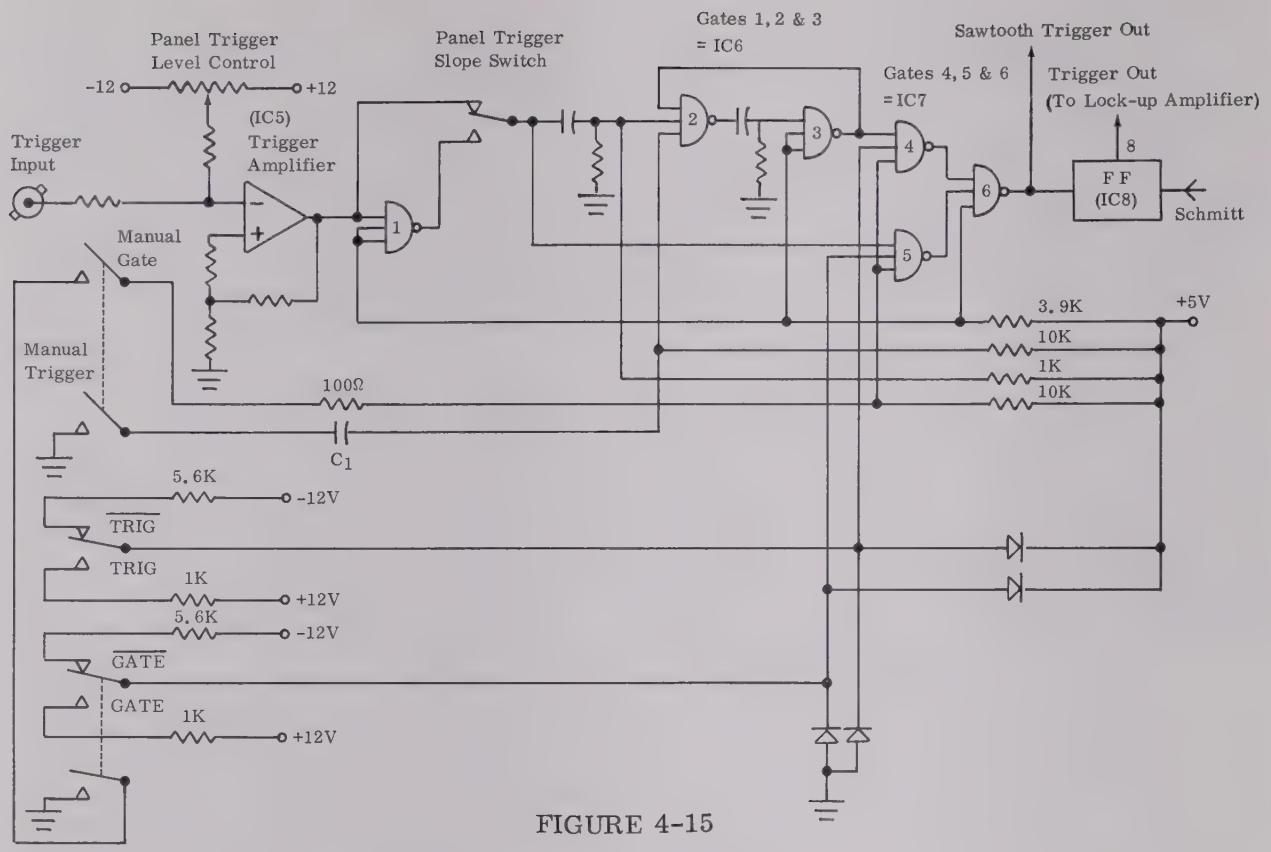


FIGURE 4-15

multivibrator described above, thus it will be + when the multivibrator is in its stable state.

The third input is connected to the Trigger Mode Switch. With the switch in its normal (TRIG) position, this input is held at some slightly negative voltage, and the gate is therefore disabled. When the TRIG mode is selected this input is raised to some + level and the gate is now enabled, and its output goes to zero.

Gate #5: This gate is very much like Gate 4, the only difference being the origin of the two gating signals. One of these inputs is enabled when the GATE mode is selected. The other input is enabled by the output signal from the Trigger Amplifier, rather than the multivibrator. Therefore, Gate 5 is enabled as long as the signal from the Trigger Amplifier (or from the inverter) is positive.

Gate 5 is also controlled by the Manual Gate Switch, but only when the Gate Switch is depressed. As can be seen on the logic diagram, the two switches are in series, or in terms of logic, the two switches make up an AND gate.

Gate #6: This gate also has one input connected to the +5 volt supply at all times. The other inputs are controlled by either Gate 4 or Gate 5. Inasmuch as the Gate and Trigger switches are latching, it is not logically possible to be in both modes at the same time, therefore the output from Gate 4 or from Gate 5 is always positive. From the discussion above, one of these inputs will go negative when an output is desired, and at no other time. The output of Gate 6 is used as a trigger signal to start the internal sawtooth generator, and is also fed to a Flip-Flop, which in turn determines the condition of the Lock-up Amplifier.

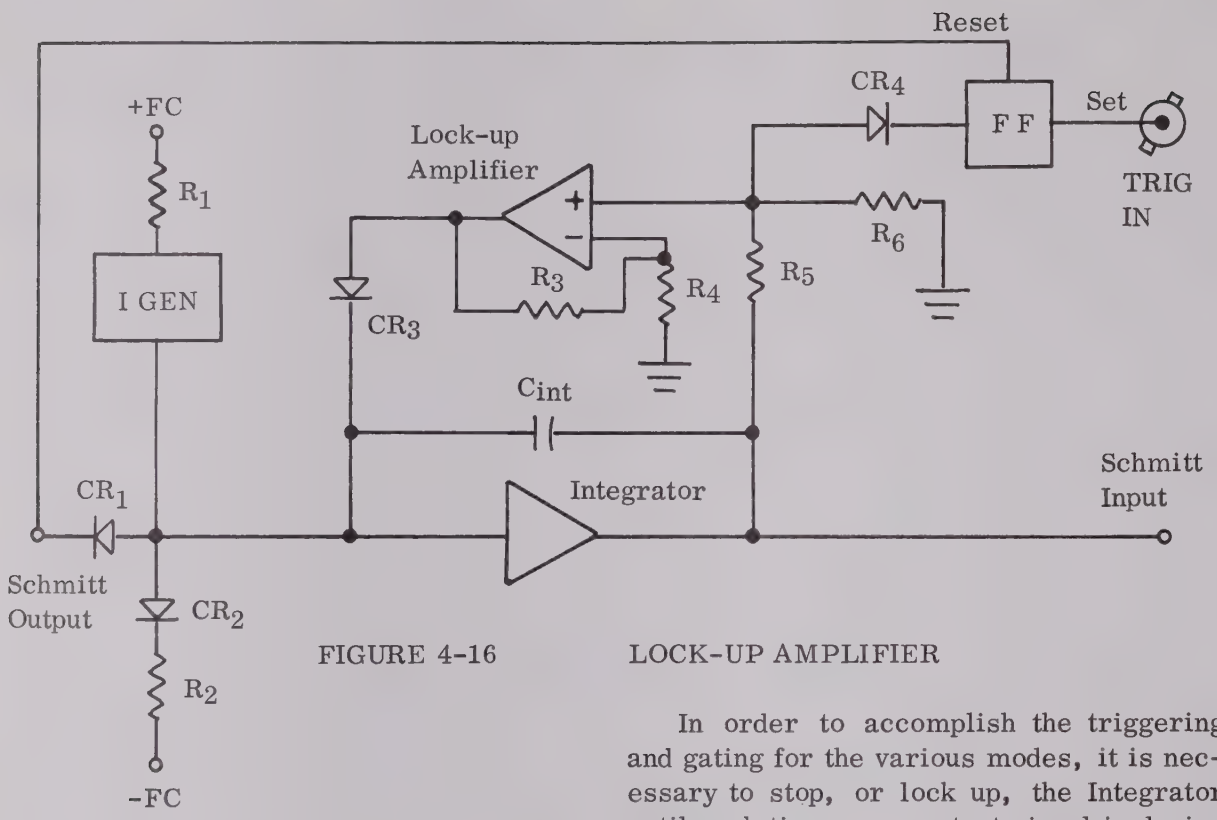
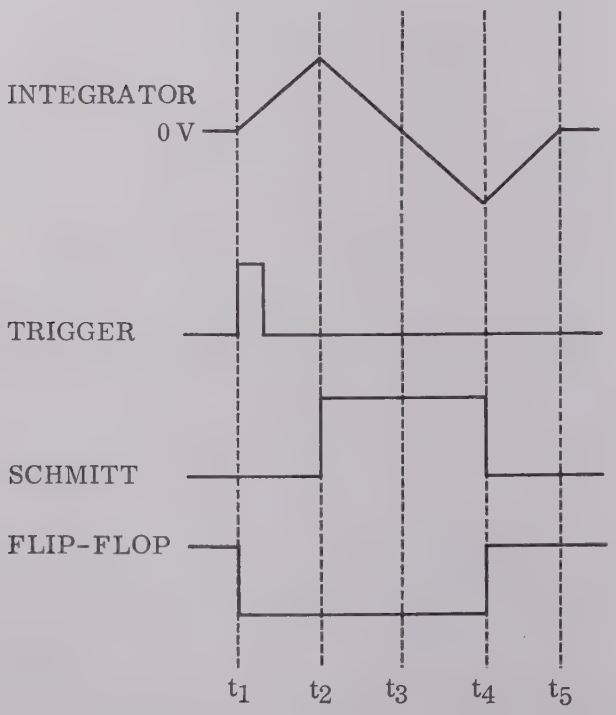


FIGURE 4-16



LOCK-UP AMPLIFIER

In order to accomplish the triggering and gating for the various modes, it is necessary to stop, or lock up, the Integrator until such time as an output signal is desired. To accomplish this, an amplifier is connected around the Integrator, in such a manner that the output of this amplifier acts as a threshold at the Summing Junction of the Integrator. As depicted in Figure 4-16, this amplifier is driven from a Flip-Flop, so the input to the amplifier is either 0 or +3 volts.

In a static condition (no trigger applied) the output from the Flip-Flop is at +3 volts, thus the output of the amplifier is also at some positive voltage. Therefore, CR3 is forward biased, and any current supplied from the -F.C. amplifier is shunted away from the Integrator, and the Integrator is effectively locked up.

A trigger pulse fires the Flip-Flop, the output of which now goes negative, forward biasing CR4. This drives the output of the Lock-up Amplifier in a negative direction, and the Integrator is free to run.

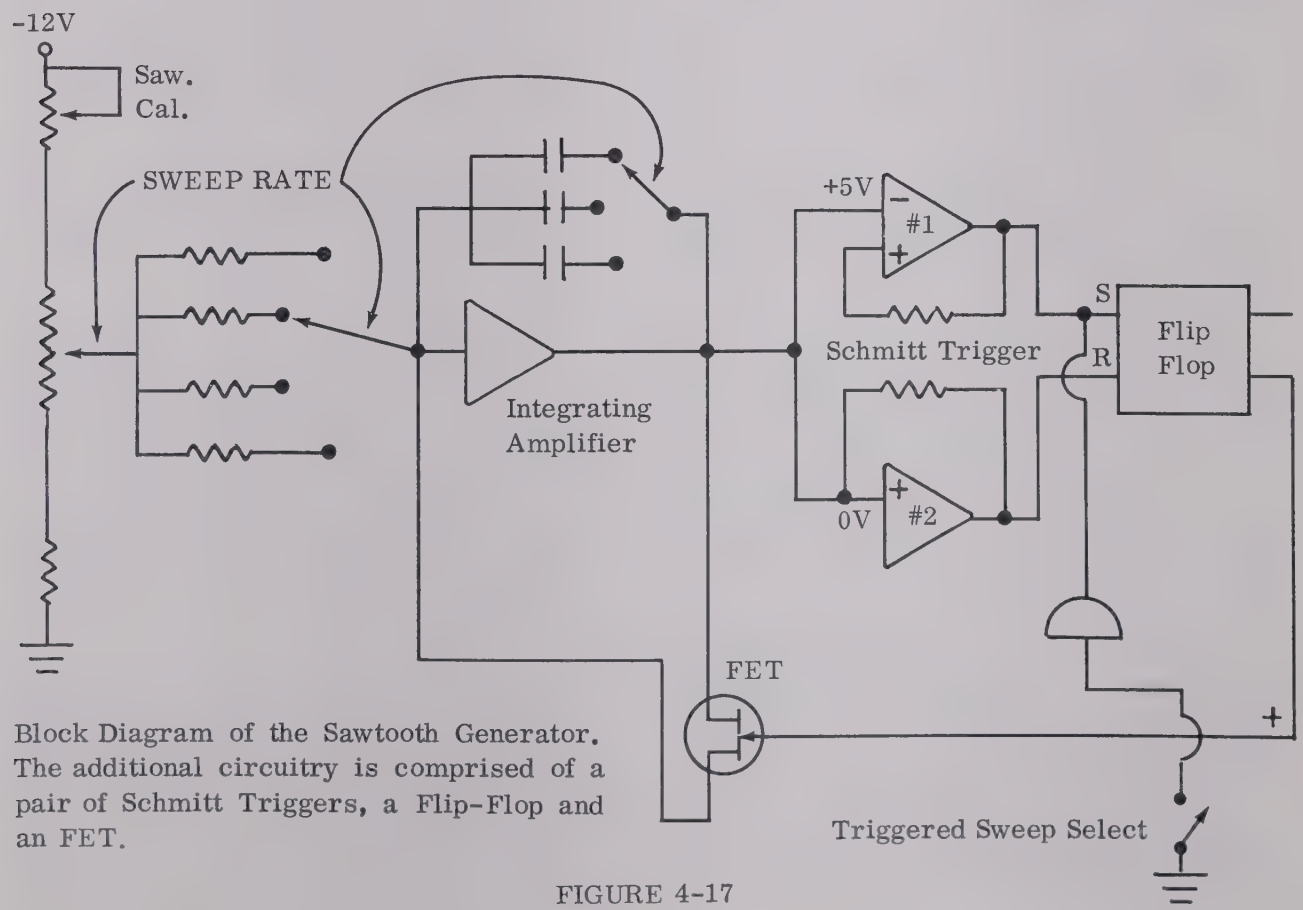
Referring to the timing chart below, the trigger pulse is applied at t_1, turning the Flip-Flop over. The Integrator charges up until its output reaches +1 volt, which is the firing point of the Schmitt Trigger. The Schmitt Trigger turns over, allowing the Integrator to discharge until it reaches its negative peak, at which time the Schmitt Trigger turns over again, and the integrating capacitor starts to charge again, at t_4. The Schmitt Trigger also is fed into the Reset side of the Flip-Flop, and its output again goes positive.

At this point CR4 is reverse biased, and it would appear that the Integrator would lock up again. However, the Integrator continues to charge until, at t_5, it reaches the threshold level originally established by the voltage division of R5 and R6.

In the circuit, R6 is actually connected to the arm of the Start/Stop Potentiometer on the Front Panel. The ends of this potentiometer are connected to the +12 volt and -12 volt supplies. Varying the Start/Stop Control varies the threshold level at the non-inverting (+) input to the Lock-up Amplifier, thus also varying the threshold level, and Start/Stop points of the Integrator.

SAWTOOTH GENERATOR

The Sawtooth Generator is, basically, an integrating amplifier. The Sawtooth Generator differs from the Integrator in the Waveform Generator Section in that circuitry has been added to eliminate the negative going slope of the normally expected Triangle waveform, so that a Sawtooth, or Ramp output is achieved.



Block Diagram of the Sawtooth Generator. The additional circuitry is comprised of a pair of Schmitt Triggers, a Flip-Flop and an FET.

FIGURE 4-17

The Schmitt Triggers are adjusted so that while the output from the integrating amplifier is rising from 0 volts to +5 volts, the outputs of both Schmitt Triggers are at +3 volts. At the time the integrator reaches +5 volts, Trigger #1 changes state, and its output goes to approximately -0.5 volts. Its output is connected to one input of a Flip-Flop, which also changes state at this time.

The Flip-Flop until this time has been in its - output condition. The negative going signal from Trigger #1 causes the output of the Flip-Flop to go from -5 volts to 0 volts. The output of the Flip-Flop is the Gate signal for the FET, so that when the Flip-Flop changes to 0 volts, the FET is turned on. This effectively shorts the integrating capacitor, so the discharge time becomes very fast, and the output of the integrating amplifier therefore drops to zero very rapidly.

Several things happen while the integrator output is dropping to zero volts.

1. As soon as the output drops below +5 volts, the input voltage to Trigger #1 is removed, resulting in its changing state, and its output returns to +3 volts.

2. As the integrator output crosses 0, Trigger #2 is triggered, and its output goes from +3 volts to -0.5 volts. This resets the Flip-Flop to its - output condition.

3. The - output from the Flip-Flip cuts the FET off, and the integrating capacitor can now charge again.

As soon as the integrator output exceeds the 0 volts level, Trigger #2 changes state, its output returns to +3 volts, and the cycle starts over again.

Figure 4-18 is a logic diagram representation of the controlling functions in the Triggered Sweep Mode.

The Trigger Amplifier and the Monostable Multivibrator work identically as discussed in the section dealing with the Triggered and Gated Modes.

Assume that the Triggered Sweep Mode has been selected, but no Trigger pulse has been applied, yet.

From the discussion above, the Integrator in the Waveform Generator portion of the instrument must be locked up until such time as an output is desired.

Also, it is desired to have the Sawtooth Generator start at the time the Trigger is applied, and thus it must be turned off until that time.

The condition of the Lock-up Amplifier is determined by the state of the JK Flip-Flop, as shown in Figure 4-18 (I.C. 8), and the condition of the Sawtooth Generator is controlled by the FET, as discussed in the section dealing with the Sawtooth Generator.

With this in mind, the most convenient place to start discussing the Triggered Sweep Mode is by considering the output of Gate 10 in Figure 4-18.

This output is at +3 volts, or a Logic 1, when the Triggered Sweep Mode is selected keeping Q8 on. Q8 in turn keeps Q9 on, and its collector is positive. This in turn keeps the FET turned on, or at it lowest resistance, thus shorting the integrating capacitor in the Sawtooth Generator, and the Sawtooth Generator is locked up, and its output level is at 0 volts.

Also, section D of the Triggered Sweep Mode Switch applies a positive voltage to the base of Q10, and Q10 is saturated, holding its collector at 0 volts. This in turn holds one input to Gate 13 at a Logic 0, and its output therefore will stay at a Logic 1, regardless of what happens at the other input.

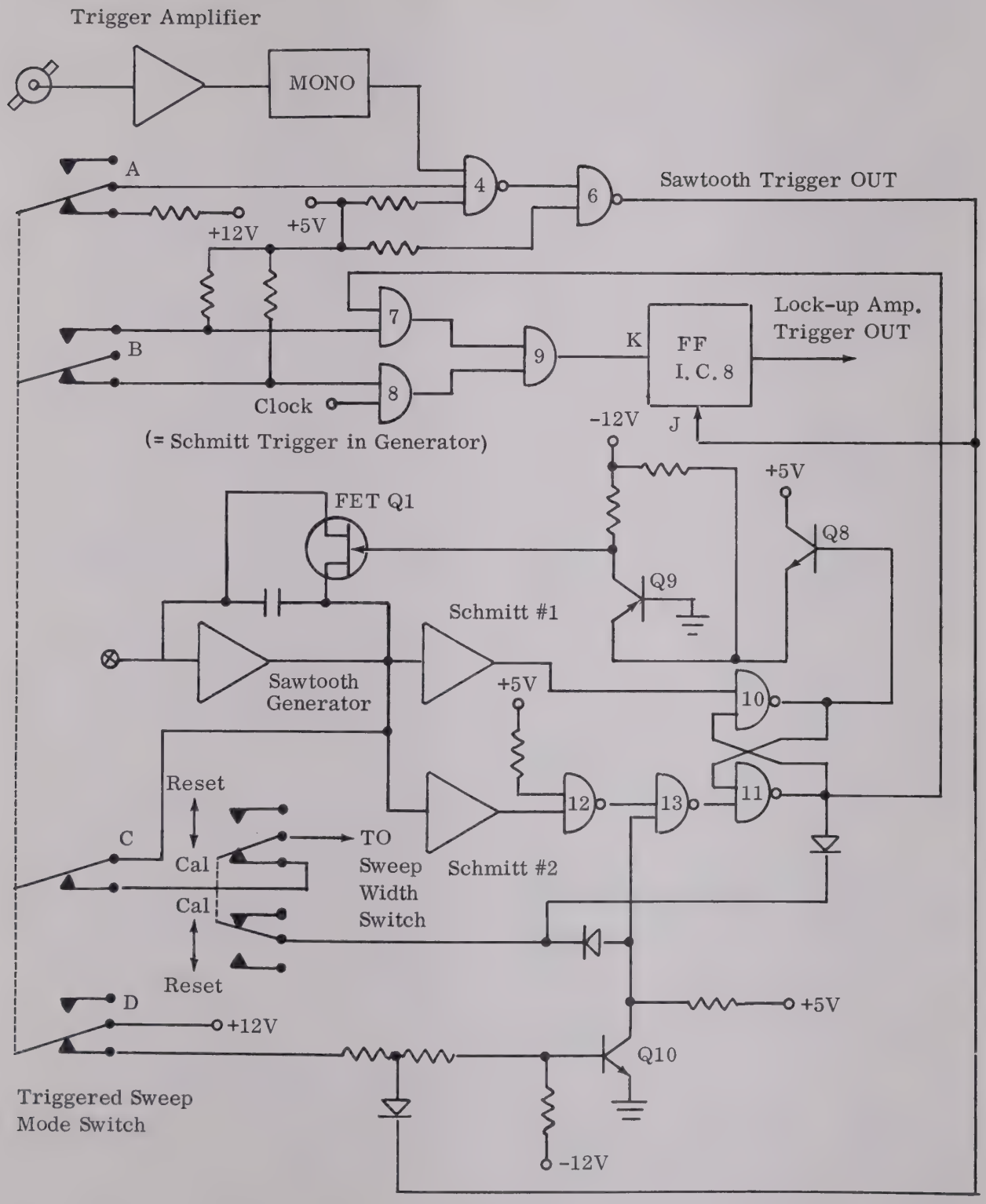

Trigger Amplifier
MONO
A
4
6
Sawtooth Trigger OUT
+12V
+5V
7
B
9
K
FF
I. C. 8
Lock-up Amp.
Trigger OUT
8
Clock
(= Schmitt Trigger in Generator)
-12V
J
+5V
FET Q1
Q8
Q9
Schmitt #1
Sawtooth
Generator
+5V
10
Reset
12
13
11
C
Cal
TO
Sweep
Width
Switch
Schmitt #2
Cal
Reset
D
+12V
+5V
Q10
Triggered Sweep
Mode Switch
-12V

FIGURE 4-18

This is done to ensure that the Flip-Flop, Gates 10 and 11, is held in the required condition to keep the FET turned on.

In the event the Triggered Sweep Mode is selected while the Sawtooth Generator output is at something other than 0 volts, Schmitt #1 would fire at the peak of the Sawtooth setting the Flip-Flop in the condition to stop the Sawtooth Generator. Schmitt #2 would fire as soon as the Sawtooth Generator output reached 0 volts, and if it was not prevented by Q10, the output from Schmitt #2 would reset the Flip-Flop, and the Sawtooth Generator would keep running.

Now, assume that a Trigger pulse is applied. The Trigger Amplifier will fire the Mono-stable Multivibrator, and a negative pulse will be generated from the Mono-stable Multivibrator. This will ultimately generate a negative pulse out of Gate #6, the Sawtooth Trigger Output, which is 100 nano-seconds in duration.

This output does two things; it Pre-Sets the Flip-Flop I. C. 8, unlocking the Integrator in the Waveform Generator. It also is applied to the base of Q10, cutting Q10 off, and ultimately unlocking the Sawtooth Generator.

The collector of Q10 goes positive, and the output of Gate 13 is driven to 0 volts, setting the Flip-Flop (Gates 10 and 11), so that the output of Gate 10 is at 0 volts. This cuts Q8 off, and a - voltage is applied to the Gate of the FET, therefore "opening" the FET, and the Sawtooth Generator is free to run.

The output of the Sawtooth Generator starts rising, and will continue to rise until it reaches the firing potential of Schmitt #1, at which time the output of Schmitt #1 goes negative, changing the state of the Flip-Flop (Gates 10 and 11).

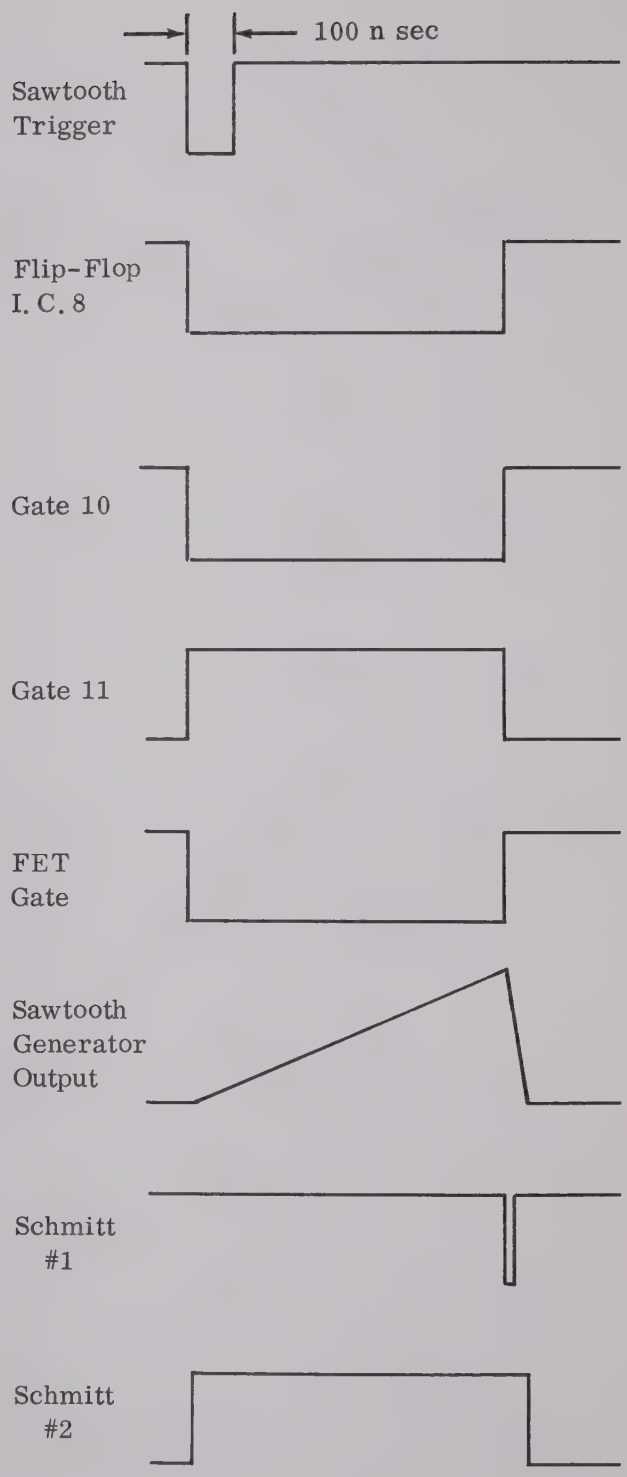


FIGURE 4-19

The negative signal from Gate 11 is applied to the input of Gate #7 and on through Gate 9 to the K input of the Flip-Flop, the output of which again goes positive, locking the Integrator up.

The positive signal from Gate 10 is applied to Q8, driving it into conduction, and the FET is again turned on, shorting the integrating capacitor, and the Sawtooth Generator is also locked up. Nothing further can happen until another Trigger Pulse is applied to the Trigger Input.

Figure 4-19 is a timing diagram of the events during the Triggered Sweep Cycle.

POWER SUPPLIES

All power supplies are located on the Master Board Assembly.

The +12 volt and -12 volt supplies are regulated supplies, the -12 volt supply slaved to the +12 volt supply. The supplies are identical in operation, therefore only the +12 volt supply will be discussed.

Regulation of the +12 volt supply is accomplished by the passing transistor, Q4. The output voltage is divided down through R19, R20 and R21 to provide a variable control voltage at the inverting (-) input of a differential amplifier, IC1.

The output voltage is also the source for Q24, which is connected as a zener diode. Q24 breaks down at +6.7 volts, and keeps a constant voltage at the non-inverting (+) input of IC1.

A drop in output voltage causes a less positive voltsge at the inverting (-) input of IC1, which results in a more positive voltage at the output, pin 6. This voltage is applied to the gate of FET, Q5, causing it to conduct more, which pulls the base of Q4 more negative. This results in increased conduction through Q4, which in turn raises the output voltage.

The 24 volt regulated supply is a simple series regulator. The collector of Q1 is supplied from the unregulated +32 volt supply. The base of Q1 is held at a constant voltage by CR12, which holds the conduction of Q1 constant, thereby keeping the emitter voltage constant. The current requirement of the +24 volt supply is very slight, as it is used only for bias voltage for current generators in other parts of the unit.

The +24 volt and -24 volt unregulated supplies, and the +32 volt and -32 volt supplies are derived from respective bridge rectifiers with a single section capacitive filter in each case. These supplies are used only to supply the necessary power for the Output Amplifier, and need not be regulated because of the relatively large amount of feedback used in the Output Amplifier.

MAINTENANCE

SECTION V

MAINTENANCE

General:

This section contains information relative to preventive and corrective maintenance. The portion dealing with corrective maintenance contains troubleshooting and corrective procedures.

Parts identification is provided on photographs of each circuit board or sub-assembly. Each photograph is on the page facing the schematic of the assembly in question.

A complete parts list for each assembly is contained on the page(s) immediately preceding each photograph.

The majority of electronic parts used in this instrument are standard, commercial parts, and replacement parts may be obtained locally. Precision components and mechanical parts, however, should be obtained through Data Royal Corporation's representative in your area.

Preventive Maintenance:

In general, no preventive maintenance, as such, is required. Occasional cleaning is recommended, and can be accomplished in conjunction with routine calibration.

A calibration cycle of six months is recommended for areas of normal operating conditions.

Re-calibration is necessary because the calibration of any instrument changes with age, use and operating conditions. Also, problems which may not be apparent during normal use will show up during a calibration check. See Section III for complete calibration procedure.

Corrective Maintenance:

Figure 5-1 is the logical representation of the procedure designed to assist in the location of any problem. This procedure is based on a systematic analysis of the instrument circuits in order to localize the problem.

This procedure should be undertaken only after it has been established that the problem can not be corrected by following the Adjustment and Calibration Procedures, as detailed in Section III. It should also be determined that the problem is not caused by conditions outside the Model F230A.

Table 5-1 contains a list of the normal indications for each of the checks listed in Figure 5-1. The steps outlined in Figure 5-1 are intended only to help localize the problem to an area within the instrument. Therefore, additional measurements will be required to completely isolate the problem within a specific circuit.

Table 5-2 contains a list of typical voltages as measured at a number of active components throughout the instrument.

Component parameters will vary from one instrument to the next, therefore, the voltage levels listed may not exactly equal readings obtained during the troubleshooting procedure.

NORMAL INDICATIONS

1. All outputs, corresponding to the Function Switch selected.

2. All outputs, as marked at each BNC connector.

3. -10 volt pulse, 2 μseconds wide.

4. Varying the Frequency Control should vary the output over a 20:1 frequency span within any given range.

5. Applying 1.000 volts should raise the output frequency by 20% of full scale on any range.

6. Each consecutive position should change the output frequency by a factor of 10, the Range Multiplier in either X1 or X3.

7. Fixed steps of -20dB and -40dB attenuation of the output signal.

8. Vernier amplitude control of the output signal.

9. Normal signal at the Triangle T. P. is a ±1 volts triangle waveform (2v peak-to-peak), which is the output of the integrating amplifier. As described in Section IV, the Integrator, the Schmitt Trigger and the Constant Current Generator constitute a "closed loop". All three circuits, therefore, must work in order to get a triangle output.

   To troubleshoot the Integrator, ground the Summing Junction (left end of the .0022 capacitor, C34). Now vary the Integrator Zero pot (R79) from CCW to CW. The DC level at the Triangle T. P. should vary from approximately -5 volts to +5 volts.

10. To troubleshoot the Schmitt Trigger ground the Integrator Summing Junction as in 9 above. Vary the Integrator Zero pot as in 9, while monitoring the Schmitt output. (Green T. P. in right corner at the front of the Generator Board. The Schmitt output should swing from -0.6 volts to +0.6 volts.

    The Current Generator either works or it doesn't. If it works, the Green T. P. near Q11 will measure approximately +5 volts. The actual voltage is not extremely critical, but whatever it is, it must be stable.

TABLE 5-1

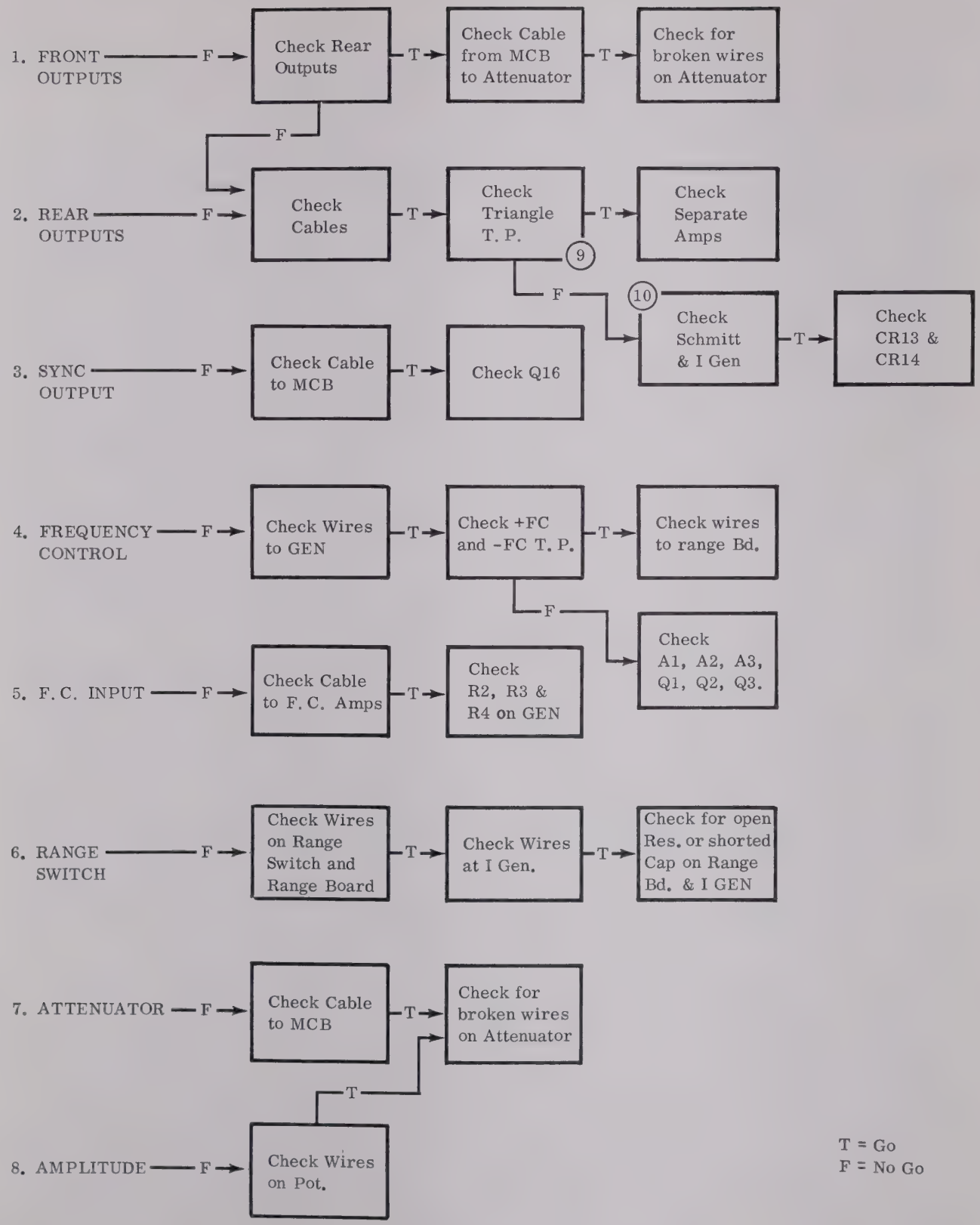

1. FRONT OUTPUTS
F
Check Rear Outputs
T
Check Cable from MCB to Attenuator
T
Check for broken wires on Attenuator
F
2. REAR OUTPUTS
F
Check Cables
T
Check Triangle T. P.
T
Check Separate Amps
9
F
10
Check Schmitt & I Gen
T
Check CR13 & CR14
3. SYNC OUTPUT
F
Check Cable to MCB
T
Check Q16
4. FREQUENCY CONTROL
F
Check Wires to GEN
T
Check +FC and -FC T. P.
T
Check wires to range Bd.
F
Check A1, A2, A3, Q1, Q2, Q3.
5. F. C. INPUT
F
Check Cable to F. C. Amps
T
Check R2, R3 & R4 on GEN
6. RANGE SWITCH
F
Check Wires on Range Switch and Range Board
T
Check Wires at I Gen.
T
Check for open Res. or shorted Cap on Range Bd. & I GEN
7. ATTENUATOR
F
Check Cable to MCB
T
Check for broken wires on Attenuator
T
8. AMPLITUDE
F
Check Wires on Pot.
T = Go
F = No Go

FIGURE 5-1

TABLE 5-2

TYPICAL VOLTAGE LEVELS

1. MASTER BOARD

	Emitter	Base	Collector
Q1	+23.5	+24.0	+32.0
Q2	+17.5	+17.0	+16.5
Q3	-17.5	-17.0	-16.5
Q4	+17.5	+16.5	+12.00
Q7	-12.00	-17.0	-16.5
Q8	+ 8.5	0	0
Q9	- 9.0	0	0
Q10	+11.5	+ 6.7	+ 7.2
Q11	0	+ 6.7	+ 6.3
Q12	0	- 6.9	- 6.5
Q13	-11.5	- 6.9	- 7.4
Q14	+10.5	0	---
Q15	-10.5	0	---
Q16	+11.5	0	- 0.5
Q17	- 0.2	- 0.2	0
Q18	- 0.2	- 0.3	0
Q19	0	0	+12.00
Q20	-11.0	- 0.7	- 1.3
Q21	+ 5.0	+30.0	+29.5
Q22	+26.5	+ 4.0	+ 5.0
Q23	-26.0	+ 4.2	+ 3.7
Q24	+ 0.3	- 0.4	+ 5.8
Q25	+ 5.4	+ 6.0	+ 7.2
Q26	+ 7.0	+ 7.7	+10.0
Q27	+ 0.6	+ 6.0	+ 6.6

	Emitter	Base	Collector
Q28	0	+ 0.6	+10.5
Q29	- 0.3	- 0.9	-10.0
Q30	0	N.C.	+ 7.0

	Source	Gate	Drain
Q5	0	- 1.2	+12.5
Q6	0	+ 3.8	-13.0

CR12	24v ±10%
CR20	5.6v ±10%
CR23	12v ±10%
CR24	24v ±10%
CR27	20v ±10%
CR28	3.6v ± 5%
CR33	6.2 v ±10%

NOTE:
All readings taken with 20,000 ohms/volt meter, Triplett 630 or equivalent.
All readings taken with respect to TP2 (Ground).
Take measurements in Normal Mode, Sawtooth Generator "OFF".

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
IC1	+10.0	+ 6.9	+ 6.8	-15.5	-15.0	- 1.2	+15.5	+11.5						
IC2	+10.0	0	0	-15.5	-15.0	+ 4.0	+15.5	+11.5						
IC3	+ 5.5	+ 6.4	- 0.4	- 1.1	+ 6.4	- 0.25	- 1.1	+ 6.7	N.C.	N.C.	N.C.	-12.00		
IC4	N.C.	N.C.	0	- 0.7	+ 7.3	0	- 0.7	+ 8.5	N.C.	- 4.3	N.C.	N.C.		
IC5	0	0	+ 0.6	- 5.8	N.C.	N.C.	- 0.4	+12.0	+ 4.7					
IC6	+ 4.7	+ 4.7	+ 0.3	+ 4.7	+ 4.7	+ 3.7	N.C.	0	+ 2.7	+ 3.7	+ 2.7	+ 3.5	+ 2.5	+ 5.0
IC7	- 0.6	+ 4.6	+ 3.8	+ 4.6	+ 3.7	+ 0.1	0	+ 3.7	+ 4.6	+ 3.5	- 0.5	+ 3.8	+ 3.7	+ 5.0
IC8	+ 0.1	0	+ 0.1	0	+ 0.1	+ 3.7	0	0	+ 0.1	+ 1.9	+ 0.1	0	+ 4.6	+ 5.0
IC9	N.C.	N.C.	0	- 0.75	+ 7.6	0	- 0.75	+ 5.7	0	- 6.0	0	0		

2. GENERATOR BOARD

	Emitter	Base	Collector
Q1	- 0.6	+ 0.1	+12.0
Q2	- 0.6	0	- 2.7
Q3	- 1.5	- 1.6	+12.0
Q4	+ 4.0	+ 3.8	- 6.0
Q5	+ 3.3	+ 2.8	- 6.0
Q6	- 6.0	- 6.7	- 9.2
Q7	+ 4.0	+ 3.3	- 5.6
Q8	- 6.0	- 5.6	0
Q9	0	0	+11.6
Q13	- 1.0	- 0.1	+11.6
Q14	- 1.0	- 0.1	+ 8.5
Q15	+ 7.8	+ 8.5	+11.6
Q16	- 5.5	- 4.7	- 0.7
Q17	0	+ 0.7	+11.6
Q18	0	- 0.7	-11.6
Q19	0	- 0.6	-12.00
Q20	0	+ 0.7	+12.00
Q21	0	0	+11.8
Q22	0	0	-11.8
Q23	+ 0.25	- 0.35	-12.00
Q24	- 0.3	+ 0.35	+12.00
Q25	+ 0.05	- 0.5	-12.00
Q26	- 0.05	+ 0.5	+12.00
Q27	- 0.1	- 0.75	-12.00
Q28	+ 0.1	+ 0.75	+12.00
Q29	- 0.2	- 0.8	-12.00
Q30	+ 0.2	+ 0.8	+12.00

	Emitter	Base	Collector
Q31	- 0.2	- 0.8	-12.00
Q32	+ 0.2	+ 0.8	+12.00
Q33	- 0.2	- 0.8	-12.00
Q34	+ 0.2	+ 0.8	+12.00
Q35	+ 7.8	+ 8.4	+11.6
Q36	+ 7.5	+ 6.8	+ 0.7
Q37	0	+ 0.7	+10.2
Q38	- 0.2	- 0.7	-10.2

	Source	Gate	Drain
Q10	+ 6.0	+ 4.8	+23.7
	+ 6.0	+ 5.0	+23.7
Q11	+ 5.0	+ 8.6	+ 0.25
Q12	+ 1.1	+12.00	0
	+ 1.1	+12.00	- 0.05

CR2	3.6v ± 5%
CR3	6.8v ± 5%
CR4	8.7v ± 5%
CR11	6.8v ± 5%
CR14	12v ±10%
CR17	6.2v ±10%

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
IC1	N.C.	N.C.	- 1.5	- 2.4	- 1.6	- 2.0	- 2.4	+12.0	N.C.	-10.0	N.C	N.C.		
IC2	0	0	- 0.3	- 6.0	N.C.	N.C.	+ 3.0	+11.5						
IC3	0	+ 0.3	0	- 6.0	N.C.	N.C.	+ 2.8	+11.6						
IC4	+11.7	+11.2	+ 5.6	+ 5.6	N.C.	0	N.C.	N.C.	+11.7	+18.5	+18.0	+12.0	+23.5	+15.7
IC5	+ 7.4	+ 1.0	+ 1.0	-12.0	-11.3	0	+12.0	+ 8.4						
IC6	- 1.5	- 0.75	- 0.75	- 1.5	+ 6.8	0	- 0.75	+11.8	0	- 4.8	+11.8	+ 8.4		

3. FREQUENCY CONTROL BOARD

	Emitter	Base	Collector
Q1	- 5.0	- 5.9	-12.00
Q2	+19.0	+18.0	+10.0
Q3	+ 1.7	+ 1.0	-10.8

CR3	6.8v ±5%
CR4	8.7v ±5%

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A1	- 1.4	- 0.7	- 0.7	- 1.4	+ 4.0	0	- 0.7	+ 4.0	0	-12.0	+ 4.0	+ 4.0		
A2	+ 0.5	0	- 1.3	- 1.4	N.C.	-12.0	N.C.	-12.0	+ 0.5	+ 7.0	+ 2.0	+ 1.0	+12.0	+ 3.7
A3	+ 0.5	0	0	0	0	-12.0	N.C.	-12.0	+ 0.5	+ 6.6	+ 1.7	+ 1.0	+12.0	+ 4.4

4. SAWTOOTH GENERATOR

	Emitter	Base	Collector
Q2	0	+ 1.4	- 7.5
Q4	+10.3	+11.0	+11.6
Q5	+10.0	+ 9.3	+ 3.8
Q6	+ 3.1	+ 3,6	+10.7
Q7	+ 2.6	+ 2.0	-11.2
Q8	- 0.5	+ 0.1	+ 5.0
Q9	- 0.5	0	- 4.6
Q10	0	- 0.5	+ 5.0

	Drain	Gate	Source
Q1	0	- 4.6	+ 2.6
Q3A	-12.0	0	+ 1.4
Q3B	-12.0	0	+ 1.2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
IC1	0	- 2.0	- 1.9	- 2.6	+ 9.2	- 1.1	- 1.8	+ 6.7	- 1.3	- 5.6	+ 6.8	+11.0		
IC2	0	0	- 1.7	- 5.3	N.C.	N.C.	+ 2.2	+12.0						
IC3	0	+ 1.0	0	- 5.3	N.C.	N.C.	+ 2.2	+12.0						
IC4	+ 2.2	+ 4.7	+ 0.1	+ 5.0	+ 0.1	+ 3.8	0	+ 3.4	+ 3.8	+ 0.25	+ 0.25	+ 2.3	+ 3.5	+ 5.0

NOTE:

All readings taken with 20,000 ohms/volt meter Triplett 630 or equivalent, with respect to TP2 (Ground). Measurements taken with Sweep Rate Switch in 100K position.

PARTS LIST

DATA ROYAL ASSEMBLY: F230A GENERATOR BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90040-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
CAPACITORS						
C1	3pf	MICA	500V	04062	DM15-030-D	21-57628-0
C2	20pf	CER DISC	1000V	71590	DD-200	21-57011-0
C3	10μf	ELECT	25V	56289	TE1204	21-57202-0
C4	10μf	ELECT	25V	56289	TE1204	21-57202-0
C5	9-35pf	VAR CER		72982	538-002-94D	21-63200-0
C6	75pf	MICA	500V	04062	DM15-750J	21-57631-0
C7	9-35pf	VAR CER		72982	538-002-94D	21-63200-0
C8	47pf	MICA	500V	04062	DM-15-470J	21-57627-0
C9	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C10	200μf	ELECT	15V	56289	TE-1164	21-57201-0
C11	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C12	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C13	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C14	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C15	200μf	ELECT	15V	56289	TE-11-64	21-57201-0
C16	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C17	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C18	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C19	68pf	CER DISC	1000V	56289	DD-680	21-57013-0
C20	68pf	CER DISC	1000V	56289	DD-680	21-57013-0
C21	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C22		SELECTED				
C23	82pf	MICA	500V	04062	DM-15-820F	21-57630-0
C24	2-8pf	VAR CER		72982	538-002-89	21-63201-0
C25	0.0022μf	MYLAR	100V	14655	WMF-1022	21-57412-0
C26	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C27	5pf	CER DISC	1000V	56289	DD-050	21-57009-0
C28	100pf	CER DISC	1000V	56289	DD-101	21-57007-0
C29	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C30	0.022μf	MYLAR	1000V	14655	WMF-1522	21-57408-0
C31	47pf	MICA	500V	04062	DM-15-470J	21-57627-0
C32	0.005μf	CER DISC	50V	56289	TG-D50	21-57005-0
C33	0.05μf	CER DISC	50V	56289	TG-S50	21-57003-0
C34	0.05μf	CER DISC	50V	56289	TG-S50	21-57003-0
C35	0.01μf	CER DISC	50V	56289	TG-S50	21-57003-0
C36	0.01μf	CER DISC	50V	56289	TG-S50	21-57003-0
C37	0.01μf	CER DISC	50V	56289	TG-S50	21-57003-0
C38	0.01μf	CER DISC	50V	56289	TG-S50	21-57003-0
C39		SELECTED				
C40		SELECTED				
C41	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C42	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C43	560pf	CER DISC	1000V	56289	DD-561	21-57002-0
C44	10pf	CER DISC	1000V	56289	DD-100	21-57004-0
C45	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C46	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C47	5pf	CER DISC	50V	56289	DD-050	21-57009-0
C48	100μf	ELECT	25V	56289	TE-1211	21-57217-0
C49	100μf	ELECT	25V	56289	TE-1211	21-57217-0
C50	500pf	MICA	300V	04062	DM-15-501F	21-57611-0
C51	1000pf	MICA	100V	04062	DM-15-102F	21-57612-0
C52	500pf	MICA	300V	04062	DM-15-501F	21-57611-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A GENERATOR BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90040-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
RESISTORS						
R1	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R2	3.57KΩ	FILM	1/4W 1%	01121	CB1225	27-42874-0
R3	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R4	2.2KΩ	COMP	1/4W 5%	01121	CB2225	27-39278-0
R5	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R6	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R7	27KΩ	COMP	1/4W 5%	01121	CB2735	27-39289-0
R8	357Ω	FILM	1/4W 1%	12126	M1/4-357	27-42808-0
R9	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R10	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R11	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R12	1.2KΩ	COMP	1/4W 5%	01121	CB1225	27-39274-0
R13	2KΩ	COMP	1/4W 5%	01121	CB2025	27-39277-0
R14	560Ω	COMP	1/4W 5%	01121	CB5615	27-39270-0
R15	680Ω	COMP	1/4W 5%	01121	CB6815	27-39271-0
R16	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R17	3.3KΩ	COMP	1/4W 5%	01121	CB3325	27-39280-0
R18	120Ω	COMP	1/4W 5%	01121	CB1215	27-39262-0
R19	1KΩ	FILM	1/4W 1%	12126	M1/4-1K	27-42846-0
R20	1KΩ	FILM	1/4W 1%	12126	M1/4-1K	27-42846-0
R21	10.7KΩ	FILM	1/4W 1%	07115	NA60-1072F	27-42913-0
R22	2KΩ	VAR	1/2W 10%	01121	SV2021	27-49515-0
R23	2KΩ	VAR	1/2W 10%	01121	SV2021	27-49515-0
R24	10.7KΩ	FILM	1/4W 1%	07115	NA60-1072F	27-42913-0
R25	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R26	560Ω	COMP	1/4W 5%	01121	CB5615	27-39270-0
R27	340Ω	FILM	1/4W 1%	12126	M1/4-340	27-42807-0
R28	560Ω	COMP	1/4W 5%	01121	CB5615	27-39270-0
R29	82KΩ	COMP	1/4W 5%	01121	CB8235	27-39293-0
R30	340Ω	FILM	1/4W 1%	12126	M1/4-340	27-42807-0
R31	82KΩ	COMP	1/4W 5%	01121	CB5615	27-39293-0
R32	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R33	3.9KΩ	COMP	1/4W 5%	01121	CB3925	27-39281-0
R34	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R35	976Ω	FILM	1/4W 1%	12126	M1/4-976	27-42845-0
R36	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R37	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R38	1.2KΩ	COMP	1/4W 5%	01121	CB1225	27-39274-0
R39	470Ω	COMP	1/4W 5%	01121	CB4715	27-39269-0
R40	82Ω	COMP	1/4W 5%	01121	CB8205	27-39260-0
R41	330Ω	COMP	1/4W 5%	01121	CB3315	27-39267-0
R42	100KΩ	FILM	1/4W 1%	12126	M1/4-100K	27-42958-0
R43	71.5KΩ	FILM	1/4W 1%	12126	M1/4-100K	27-42958-0
R44	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R45	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R46	3.3KΩ	COMP	1/4W 5%	01121	CB3325	27-39280-0
R47	3.9KΩ	COMP	1/4W 5%	01121	CB3925	27-39281-0
R48	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R49	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R50	2.2KΩ	COMP	1/4W 5%	01121	CB2225	27-39278-0
R51	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R52	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R53	12.5KΩ	FILM	1/4W 1%	12126	M1/4-12.5K	27-46502-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A GENERATOR BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90040-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
RESISTORS (Continued)						
R54	4.167KΩ	FILM	1/4W 1%	12126	M1/4-4.167K	27-46500-0
R55	125KΩ	FILM	1/4W 1%	12126	M1/4-125K	27-46507-0
R56	41.67KΩ	FILM	1/4W 1%	12126	M1/4-41.67K	27-46505-0
R57	1.25MΩ	FILM	1/4W 1%	12126	M1/4-1.25K	27-46511-0
R58	416.7KΩ	FILM	1/4W 1%	12126	M1/4-416.7K	27-46509-0
R59	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R60	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R61	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R62	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R63	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R64	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R65	10KΩ	VAR	1/2W 10%	01121	SV1031	27-49513-0
R66	100KΩ	COMP	1/4W 5%	01121	CB1045	27-39294-0
R67	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R68	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R69	560Ω	COMP	1/4W 5%	01121	CB5615	27-39270-0
R70	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R71	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R72	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R73	15Ω	COMP	1/4W 5%	01121	CB1505	27-39252-0
R74	15Ω	COMP	1/4W 5%	01121	CB1505	27-39252-0
R75	3.3KΩ	COMP	1/4W 5%	01121	CB3325	27-39280-0
R76	2.2KΩ	COMP	1/4W 5%	01121	CB2225	27-39278-0
R77	560Ω	COMP	1/4W 5%	01121	CB5615	27-39270-0
R78	200Ω	VAR	1/2W 10%	01121	SV2011	27-49511-0
R79	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R80	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R81	2KΩ	COMP	1/4W 5%	01121	CB2025	27-39277-0
R82	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R83	1.5Ω	COMP	1/2W 5%	01121	EB1505	27-39508-0
R84	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R85	12Ω	COMP	1/4W 5%	01121	CB1205	27-39251-0
R86	12Ω	COMP	1/4W 5%	01121	CB1205	27-39251-0
R87	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R88	560Ω	COMP	1/4W 5%	01121	CB5615	27-39270-0
R89	49.9Ω	FILM	1/4W 1%	12126	M1/4-49.9	27-42764-0
R90	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R91	49.9Ω	FILM	1/4W 1%	12126	M1/4-49.9	27-42764-0
R92	15.4KΩ	FILM	1/4W 1%	12126	M1/4-15.4K	27-42922-0
R93	1KΩ	VAR	1/2W 10%	01121	SV1025	27-49500-0
R94	13.3KΩ	FILM	1/4W 1%	12126	M1/4-13.3K	27-42918-0
R95	13.3KΩ	FILM	1/4W 1%	12126	M1/4-13.3K	27-42918-0
R96	1KΩ	VAR	1/2W 10%	01121	SV1021	27-49500-0
R97	15.4KΩ	FILM	1/4W 1%	12126	M1/4-15.4K	27-42922-0
R98	5.6KΩ	COMP	1/4W 5%	01121	CB5625	27-39283-0
R99	5.6KΩ	COMP	1/4W 5%	01121	CB5625	27-39283-0
R100	33.2Ω	FILM	1/4W 1%	12126	M1/4-33.2	27-42758-0
R101	1.65KΩ	FILM	1/4W 1%	07115	VA60-1651F	27-42857-0
R102	182Ω	FILM	1/4W 1%	12126	M1/4-182	27-42797-0
R103	182Ω	FILM	1/4W 1%	12126	M1/4-182	27-42797-0
R104	33.2Ω	FILM	1/4W 1%	12126	M1/4-33.2	27-42758-0
R105	1.65KΩ	FILM	1/4W 1%	07115	VA60-1652F	27-42857-0
R106	2KΩ	FILM	1/4W 1%	12126	M1/4-2K	27-42860-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A GENERATOR BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90040-1

SCHEMATIC DESIGNATION	DESCRIPTION VALUE	TYPE	RATING	MANUFACTURER CODE	PART NO.	DATA ROYAL PART NO.
RESISTORS (Continued)						
R107	2KΩ	FILM	1/4W 1%	12126	M1/4-2K	27-42860-0
R108	12KΩ	COMP	1/4W 5%	01121	CB1235	27-39287-0
R109	1KΩ	FILM	1/4W 1%	12126	M1/4-1K	27-42846-0
R110	2.15KΩ	FILM	1/4W 1%	12126	M1/4-2.15K	27-42862-0
R111	1KΩ	FILM	1/4W 1%	12626	M1/4-1K	27-42846-0
R112	12KΩ	COMP	1/4W 5%	01121	CB1235	27-39287-0
R113	12KΩ	COMP	1/4W 5%	01121	CB1235	27-39287-0
R114	604Ω	FILM	1/4W 1%	12126	M1/4-604	27-42827-0
R115	562Ω	FILM	1/4W 1%	12126	M1/4-562	27-42974-0
R116	604Ω	FILM	1/4W 1%	12126	M1/4-604	27-42827-0
R117	12KΩ	COMP	1/4W 5%	01121	CB1235	27-39287-0
R118	12KΩ	COMP	1/4W 5%	01121	CB1235	27-39287-0
R119	200Ω	FILM	1/4W 1%	12126	M1/4-200	27-42798-0
R120	150Ω	FILM	1/4W 1%	12126	M1/4-150	27-42793-0
R121	200Ω	FILM	1/4W 1%	12126	M1/4-200	27-42798-0
R122	12KΩ	COMP	1/4W 5%	01121	CB1235	27-39287-0
R123	12KΩ	COMP	1/4W 5%	01121	CB1235	27-39287-0
R124	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R125	38.3Ω	FILM	1/4W 1%	12126	M1/4-38.3	27-42759-0
R126	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R127	12KΩ	COMP	1/4W 5%	01121	CB1235	27-39287-0
R128	6.8KΩ	COMP	1/4W 5%	01121	CB6825	27-39284-0
R129	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-3
R130	24.9Ω	FILM	1/4W 1%	12126	M1/4-24.9	27-42755-0
R131	10Ω	FILM	1/4W 1%	12126	M1/4-10	27-42750-0
R132	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R133	6.8KΩ	COMP	1/4W 5%	01121	CB6825	27-39284-0
R134	6.8KΩ	COMP	1/4W 5%	01121	CB6825	27-39284-0
R135	6.8KΩ	COMP	1/4W 5%	01121	CB6825	27-39284-0
R136	1KΩ	FILM	1/4W 1%	12126	M1/4-1K	27-42846-0
R137	5KΩ	VAR	1/2W 10%	01121	SV5021	27-49506-0
R138	2.1KΩ	FILM	1/4W 1%	12126	M1/4-2.1K	27-42861-0
R139	6.47KΩ	FILM	1/4W 1%	12126	M1/4-6.49K	27-42896-0
R140	1KΩ	VAR	1/2W 10%	01121	SV1021	27-49500-0
R141	4.64KΩ	FILM	1/4W 1%	12126	M1/4-4.64K	27-42884-0
R142	4.64KΩ	FILM	1/4W 1%	12126	M1/4-4.64K	27-42884-0
R143	1KΩ	VAR	1/2W 10%	01121	SV1021	27-49500-0
R144	6.49KΩ	FILM	1/4W 1%	12126	M1/4-6.49K	27-42896-0
R145	10KΩ	FILM	1/4W 1%	12126	M1/4-10K	27-42912-0
R146	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R147	10KΩ	VAR	1/2W 10%	01121	SV1031	27-49513-0
R148	10KΩ	FILM	1/4W 1%	12126	M1/4-10K	27-42912-0
R149	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R150	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R151	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R152	22Ω	COMP	1/4W 5%	01121	CB2205	27-39253-0
R153	22Ω	COMP	1/4W 5%	01121	CB2205	27-39253-0
R154	2.2KΩ	COMP	1/4W 5%	01121	CB2225	27-39278-0
R155	100KΩ	FILM	1/4W 1%	12126	M1/4-100K	27-42958-0
R156	27Ω	COMP	1/4W 5%	01121	CB2705	27-39254-0
R157	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R158	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R159	4.7KΩ	COMP	1/4W 5%	01121	CB4725	27-39282-0
R160	6.8KΩ	COMP	1/4W 5%	01121	CB6825	27-39284-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A GENERATOR BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90040-1

SCHEMATIC DESIGNATION	DESCRIPTION VALUE	TYPE	RATING	MANUFACTURER CODE	PART NO.	DATA ROYAL PART NO.
RESISTORS (Continued)						
R161	2.1KΩ	FILM	1/4W 1%	12126	M1/4-2.1K	27-42861-0
R162	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R163	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R164	20Ω	COMP	1/4W 5%	01121	CB2005	27-39308-0
R165	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R166	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R167	22Ω	COMP	1/4W 5%	01121	CB2205	27-39253-0
R168	22Ω	COMP	1/4W 5%	01121	CB2205	27-39253-0
R169	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R170	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R171	31.6KΩ	FILM	1/4W 1%	12126	M1/4-31.6K	27-42936-0
R172	31.6KΩ	FILM	1/4W 1%	12126	M1/4-31.6K	27-42936-0
R173	2.1KΩ	COMP	1/4W 5%	12126	M1/4-2.1K	27-42861-0
R174	499Ω	FILM	1/4W 1%	12126	M1/4-499	27-42821-0
R175	15.8KΩ	FILM	1/4W 1%	12126	M1/4-15.8K	27-42923-0
R176	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R177	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R178	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R179	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
SEMICONDUCTORS						
CR1		DIODE		JEDEC	1N914	27-95001-0
CR2		ZENER DIODE		JEDEC	1N5227	27-95263-0
CR3		MS7000		21845		27-95254-0
CR4		DIODE		JEDEC	1N914	27-95001-0
CR5		DIODE		JEDEC	1N914	27-95001-0
CR6		TUNNEL DIODE		JEDEC	1N3719	27-95003-0
CR7		TUNNEL DIODE		JEDEC	1N3719	27-95003-0
CR8		DIODE		JEDEC	1N914	27-95001-0
CR9		DIODE		JEDEC	1N914	27-95001-0
CR10		DIODE		JEDEC	1N914	27-95001-0
CR11		ZENER DIODE		JEDEC	1N5235B	27-95258-0
CR12		MS7000		21845		27-95254-0
CR13		MS7000		21845		27-95254-0
CR14		ZENER DIODE		JEDEC	1N5242	27-95259-0
CR15		DIODE		JEDEC	1N914	27-95001-0
CR16		DIODE		JEDEC	1N914	27-95001-0
CR17		ZENER DIODE		JEDEC	1N5234	27-95251-0
CR18		DIODE		JEDEC	1N914	27-95001-0
CR19		DIODE		JEDEC	1N914	27-95001-0
CR20		DIODE		JEDEC	1N914	27-95001-0
CR21		DIODE		JEDEC	1N914	27-95001-0
CR22		DIODE		JEDEC	1N914	27-95001-0
CR23		DIODE		JEDEC	1N914	27-95001-0
CR24		DIODE		JEDEC	1N914	27-95001-0
CR25		DIODE		JEDEC	1N914	27-95001-0
CR26		DIODE		JEDEC	1N914	27-95001-0
CR27		DIODE		JEDEC	1N914	27-95001-0
CR28		DIODE		JEDEC	1N914	27-95001-0
CR29		DIODE		JEDEC	1N914	27-95001-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A GENERATOR BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90040-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
SEMICONDUCTORS (Continued)						
CR30		DIODE		JEDEC	1N914	27-95001-0
CR31		DIODE		JEDEC	1N914	27-95001-0
CR32		DIODE		JEDEC	1N914	27-95001-0
CR33		DIODE		JEDEC	1N914	27-95001-0
CR34		DIODE		JEDEC	1N914	27-95001-0
TRANSISTORS						
Q1				JEDEC	2N274	29-04508-0
Q2				JEDEC	2N4258	29-04507-0
Q3		40235		49671		29-04532-0
Q4				JEDEC	2N3640	29-04504-0
Q5				JEDEC	2N3640	29-04504-0
Q6				JEDEC	2N3638	29-04503-0
Q7				JEDEC	2N3640	29-04504-0
Q8				JEDEC	2N4274	29-04508-0
Q9				JEDEC	2N4274	29-04508-0
Q10				JEDEC	2N3956	29-04514-0
Q11				JEDEC	2N4360	29-04513-0
Q12				JEDEC	2N3956	29-04514-0
Q13		40235		49671		29-04532-0
Q14		40235		49671		29-04532-0
Q15		40235		49671		29-04532-0
Q16		40235		49671		29-04532-0
Q17		40235		49671		29-04532-0
Q18				JEDEC	2N4916	27-04530-0
Q19				JEDEC	2N4916	29-04530-0
Q20		40235		49671		29-04532-0
Q21		40235		49671		29-04532-0
Q22				JEDEC	2N4916	29-04530-0
Q23				JEDEC	2N4916	29-04530-0
Q24		40235		49671		29-04532-0
Q25				JEDEC	2N4916	29-04530-0
Q26		40235		49671		29-04532-0
Q27				JEDEC	2N4916	29-04530-0
Q28		40235		49671		29-04532-0
Q29				JEDEC	2N4916	29-04530-0
Q30		40235		49671		29-04532-0
Q31				JEDEC	2N4916	29-04530-0
Q32		40235		49671		29-04532-0
Q33				JEDEC	2N4916	29-04530-0
Q34		40235		49671		29-04532-0
Q35		40235		49671		29-04532-0
Q36				JEDEC	2N4916	29-04530-0
Q37		40235		49671		29-04532-0
Q38				JEDEC	2N4916	29-04530-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A GENERATOR BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90040-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
INTEGRATED CIRCUITS						
I. C. 1		CA3018		49671		25-08705-0
I. C. 2		μA710C		17227		25-08701-0
I. C. 3		μA710C		17227		25-08701-0
I. C. 4		CA3030		49671		25-08706-0
I. C. 5		μA709C		17227		25-08700-0
I. C. 6		CA3018		49671		25-08705-0
RELAY						
K1		REED SWITCH		29085		27-38200-0

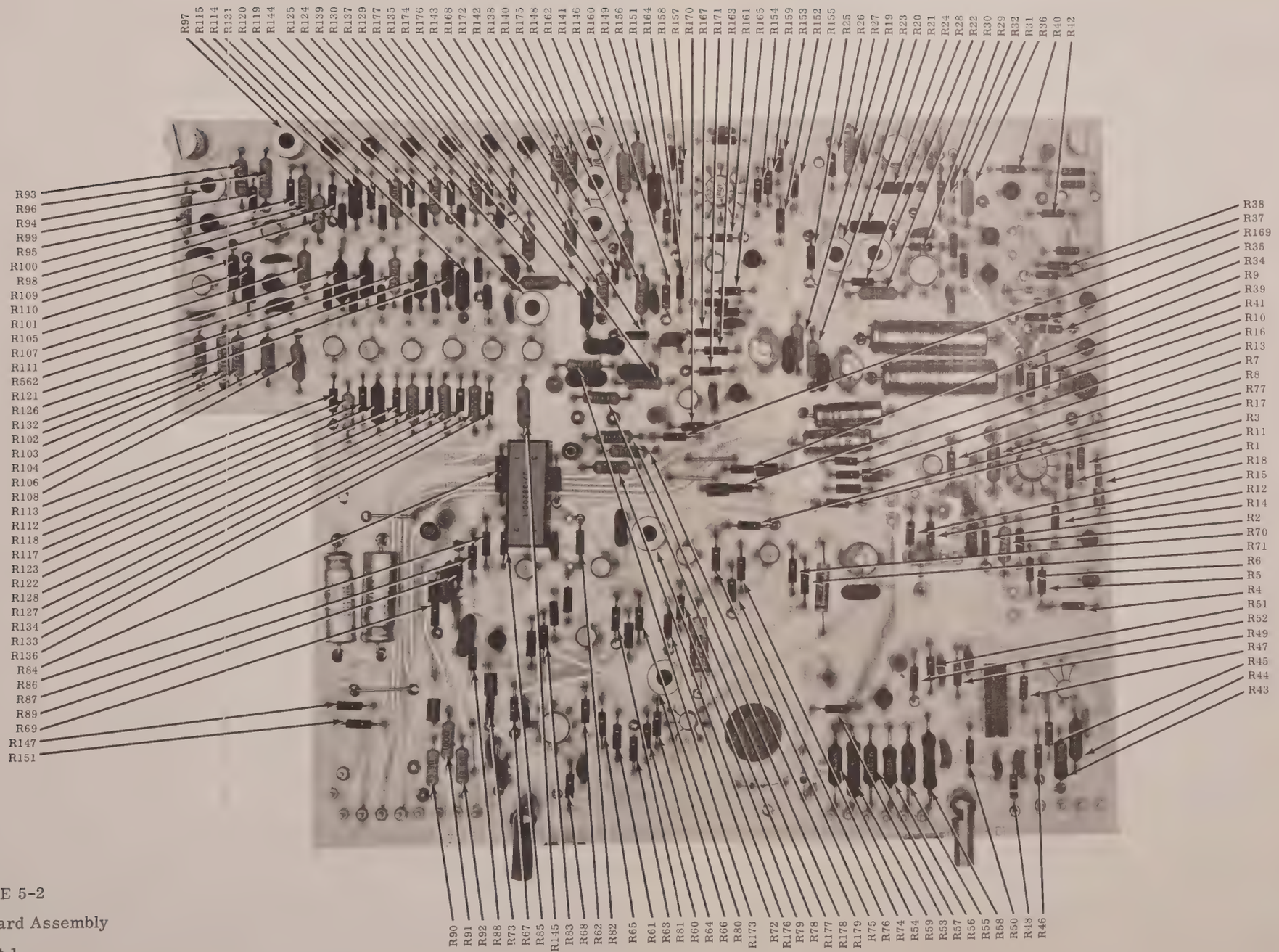


FIGURE 5-2

Generator Board Assembly

Sheet 1

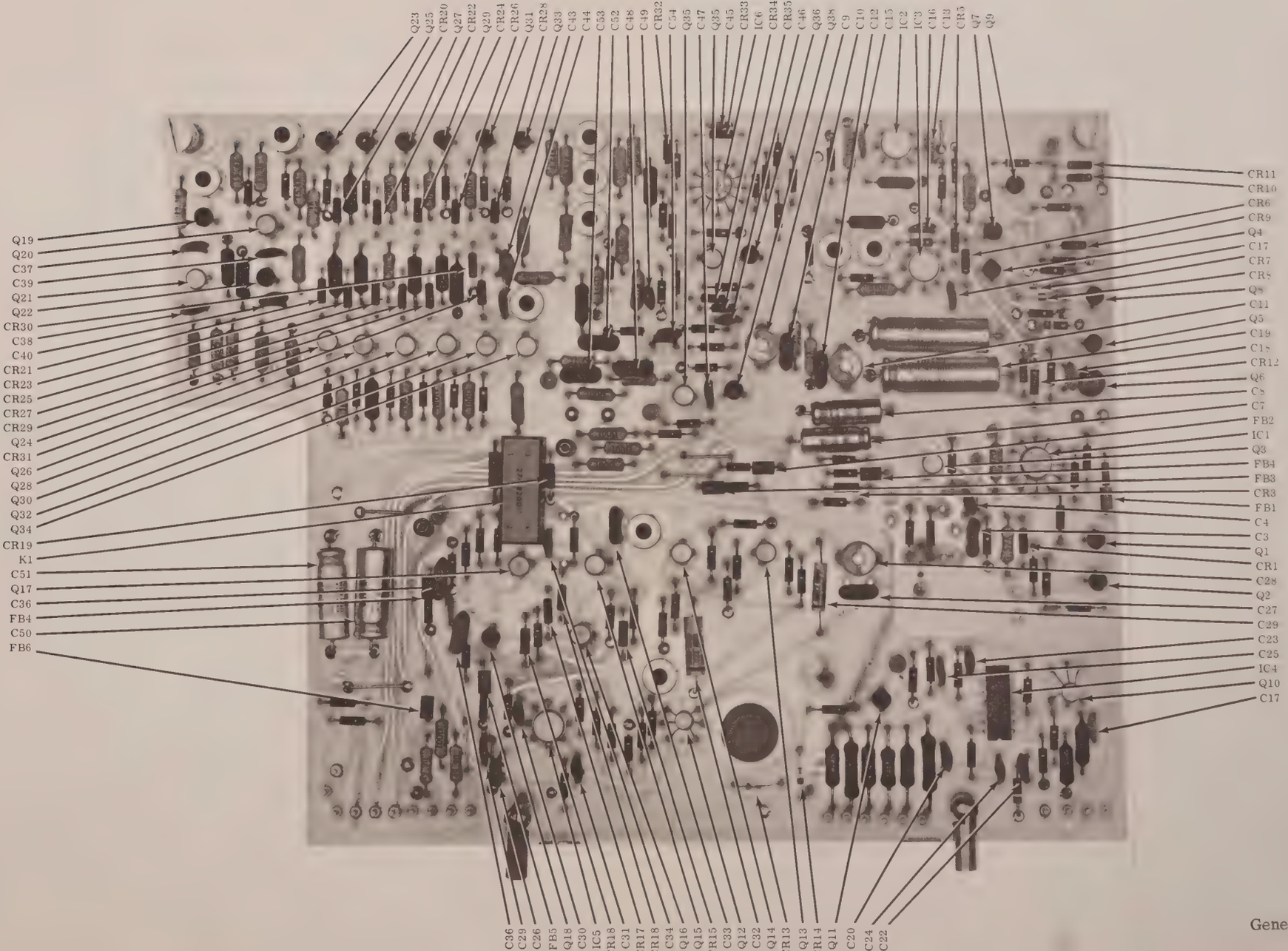
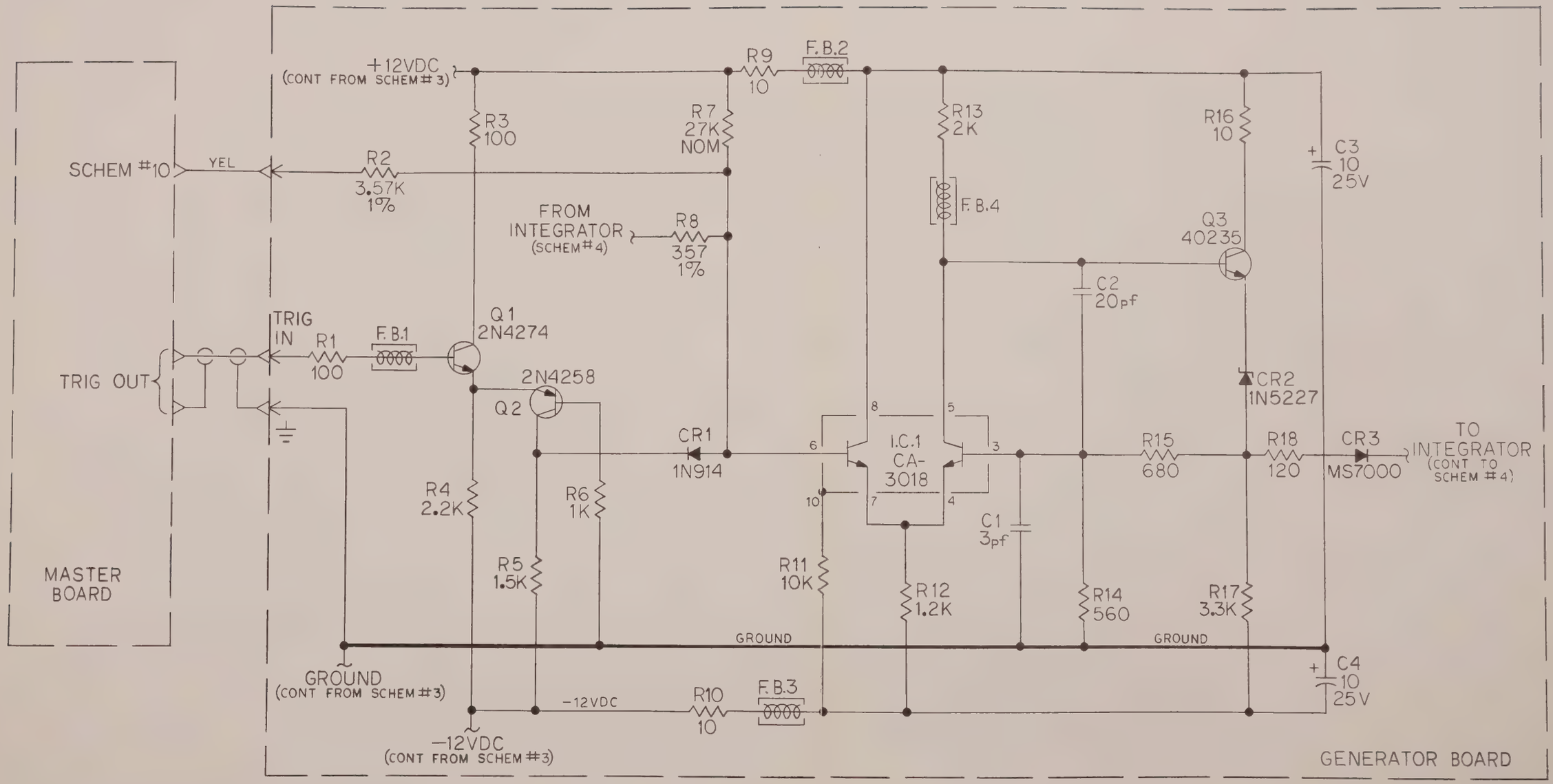


FIGURE 5-3

Generator Board Assembly

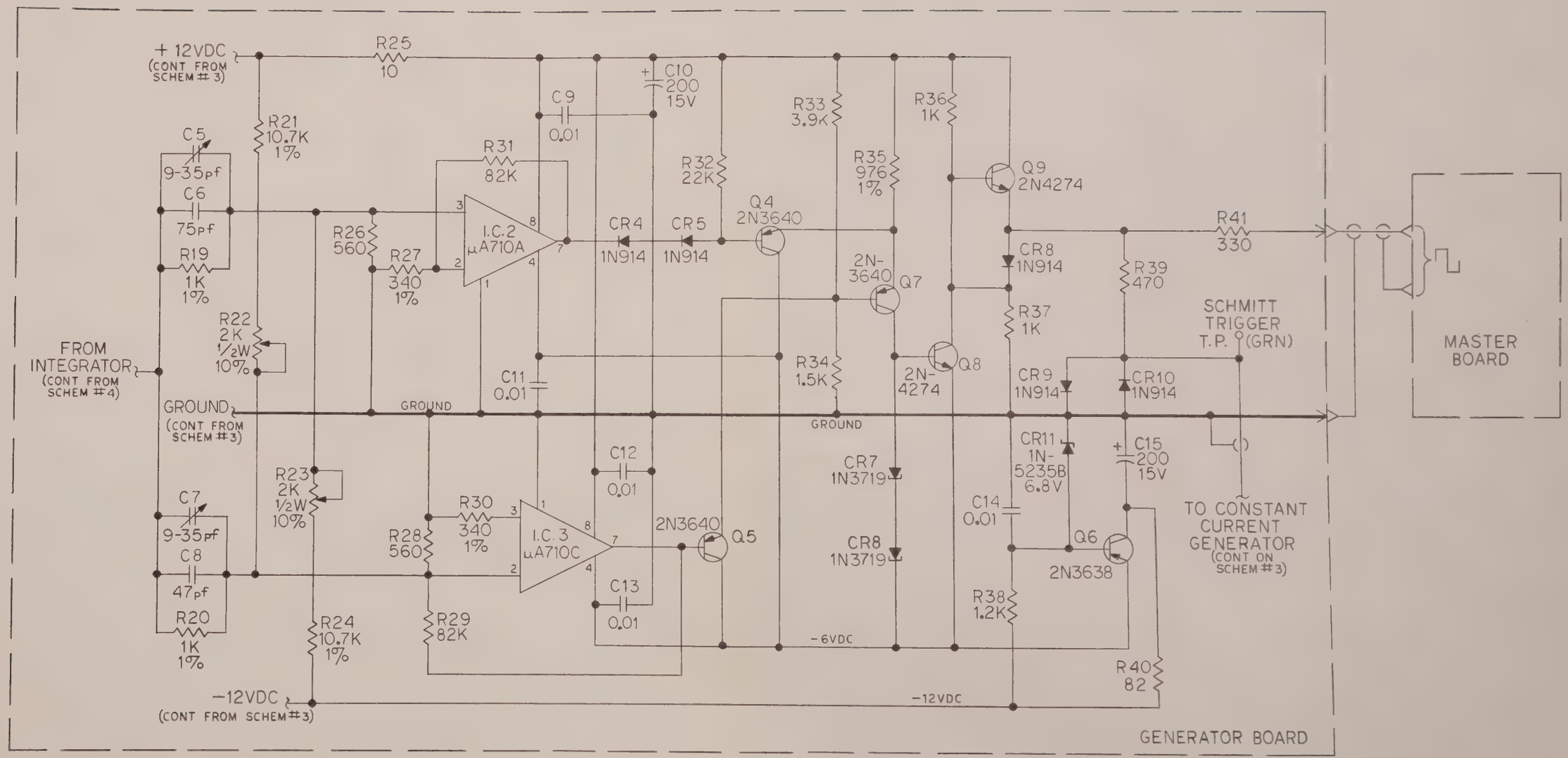
Sheet 2



NOTES~UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE 1/4W, 5%.

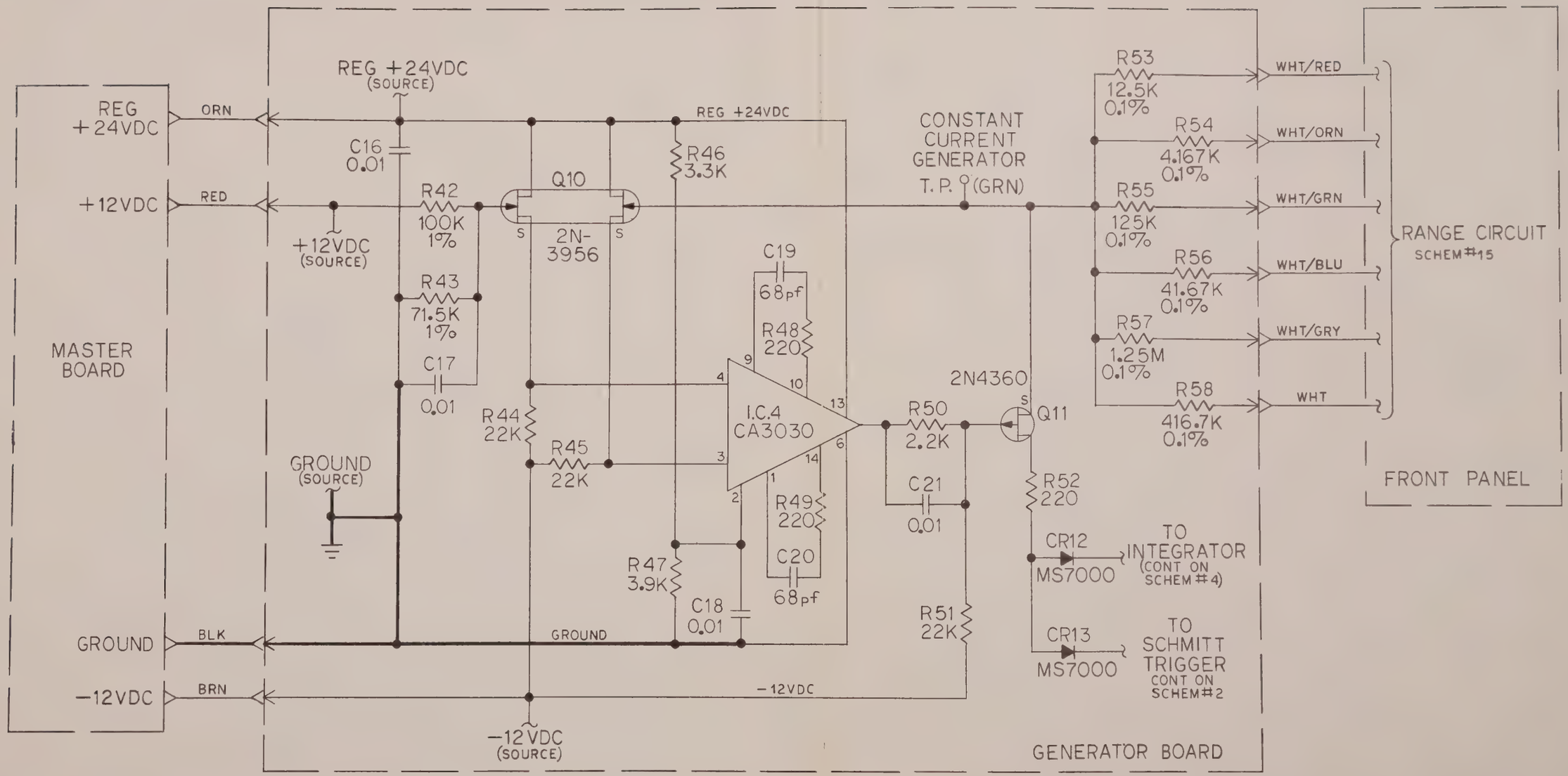
SCHEMATIC #1
Lock-up Amplifier



NOTES~UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE 1/4W, 5%.

SCHEMATIC #2
Schmitt Trigger

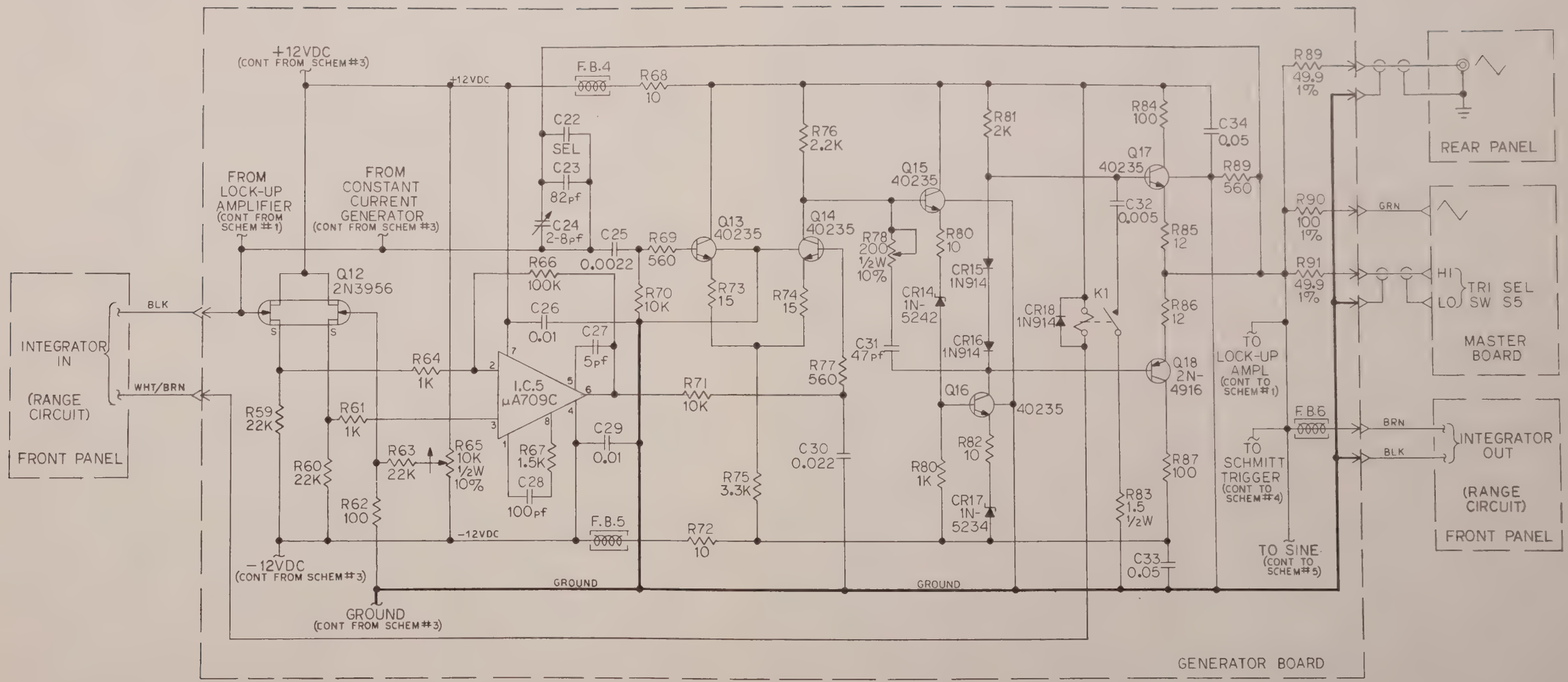


NOTES~UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE 1/4W, 5%.

SCHEMATIC #3

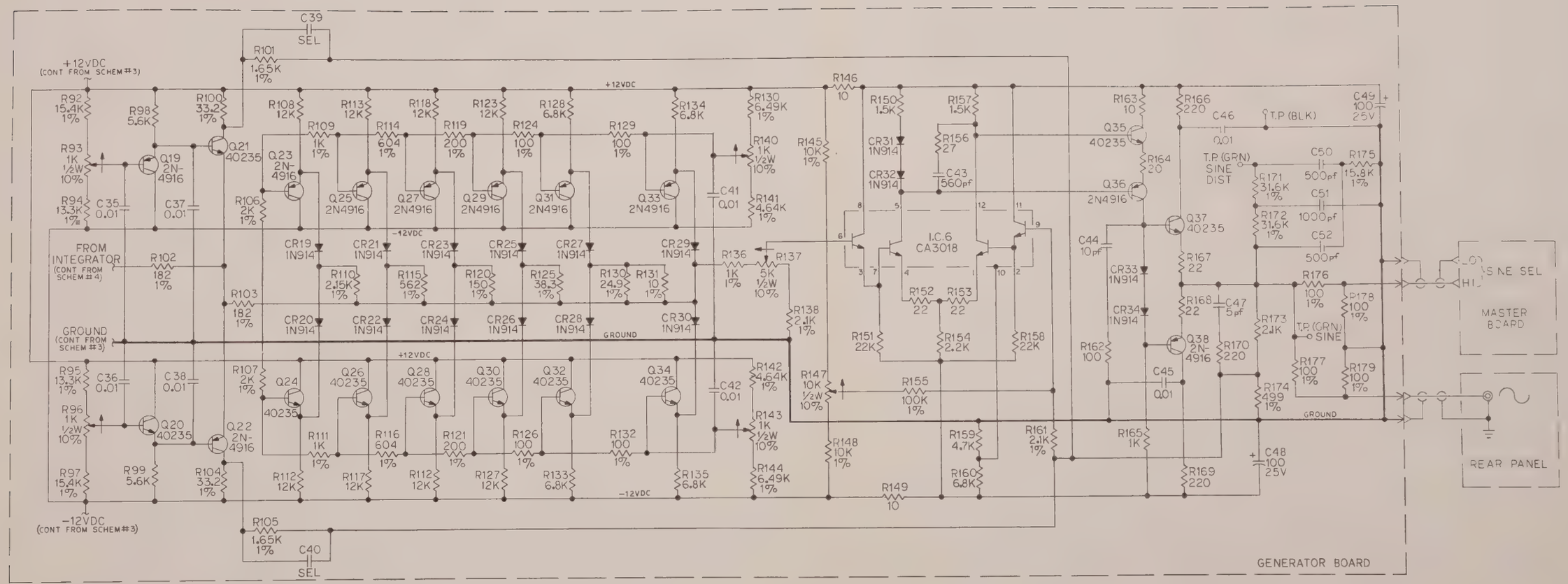
Constant Current Generator



NOTES~ UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE 1/4W, 5%.

SCHEMATIC #4
Integrator



NOTES~UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE ¼W, 5%.

SCHEMATIC #5
Sine Circuits

PARTS LIST

DATA ROYAL ASSEMBLY: F230A FREQUENCY CONTROL BOARD — DATA ROYAL PART NO. 29-90041-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
CAPACITORS						
C1	100pf	MICA	500V	04062	DM15-101J	21-57621-0
C2	10μf	ELECT	25V	56289	TE-1204	21-57202-0
C3	68pf	CER DISC	1000V	56289	DD-680	21-57013-0
C4	68pf	CER DISC	1000V	56289	DD-680	21-57013-0
C5	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C6	0.05μf	CER DISC	50V	56289	TG-S50	21-57003-0
C7	5pf	MICA	500V	04062	DM15-050K	21-57626-0
C8	0.05μf	CER DISC	50V	56289	TG-S50	21-57003-0
C9	0.05μf	CER DISC	50V	56289	TG-S50	21-57003-0
C10	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C11	5pf	MICA	500V	56289		21-57626-0
C12	68pf	CER DISC	1000V	56289	DD-680	21-57013-0
C13	68pf	CER DISC	1000V	56289	DD-680	21-57013-0
C14	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C15	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C16	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
RESISTORS						
R1	750Ω	FILM	1/4W 1%	12126	M1/4-750	27-42835-0
R2	500Ω	VAR	1/2W 10%	01121	SV5011	27-49512-0
R3	4.50KΩ	WW	1W 1%	04387	RS-1A	27-48006-0
R4	2.0KΩ	FILM	1/4W 1%	12126	M1/4-2K	27-42860-0
R5	10KΩ	FILM	1/4W 1%	12126	M1/4-10K	27-42912-0
R6	100 KΩ	FILM	1/4W 1%	12126	M1/4-100K	27-42958-0
R7	4.50KΩ	WW	1W 1%	04387	RS-1A	27-48006-0
R8	1KΩ	VAR	1/2W 10%	01121	SV1021	27-49500-0
R9	10KΩ	FILM	1/4W 1%	12126	M1/4-10K	27-42912-0
R10	500Ω	VAR	1/2W 10%	01121	SV5011	27-49512-0
R11	100KΩ	COMP	1/4W 5%	01121	CB1045	27-39294-0
R12	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R13	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R14	100KΩ	COMP	1/4W 5%	01121	CB1045	27-39294-0
R15	6.8KΩ	COMP	1/4W 5%	01121	CB6825	27-39284-0
R16	3.92KΩ	FILM	1/4W 1%	12126	M1/4-3.92K	27-42878-0
R17	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R18	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R19	33KΩ	COMP	1/4W 5%	01121	CB3335	27-39311-0
R20	10KΩ	VAR	1/2W 10%	01121	SV1031	27-49513-0
R21	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R22	20KΩ	FILM	1/4W 1%	12126	M1/4-20K	27-42927-0
R23	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R24	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R25	4.99KΩ	FILM	1/4W 1%	12126	M1/4-4.99K	27-42887-0
R26	4.53KΩ	FILM	1/4W 1%	12126	M1/4-4.53K	27-42883-0
R27	7.15KΩ	FILM	1/4W 1%	12126	M1/4-7.15K	27-42900-0
R28	500Ω	VAR	1/2W 10%	01121	SV5011	27-49512-0
R29	2.0KΩ	FILM	1/4W 1%	12126	M1/4-2K	27-42860-0
R30	500Ω	VAR	1/2W 10%	01121	SV5011	27-49512-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A FREQUENCY CONTROL BOARD — DATA ROYAL PART NO. 29-90041-1

SCHEMATIC DESIGNATION	DESCRIPTION VALUE	DESCRIPTION TYPE	DESCRIPTION RATING	MANUFACTURER CODE	MANUFACTURER PART NO.	DATA ROYAL PART NO.
RESISTORS (Continued)						
R31	4.75KΩ	FILM	1/4W 1%	12126	M1/4-4.75K	27-42885-0
R32	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R33	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R34	330Ω	COMP	1/4W 5%	01121	CB3315	27-39267-0
R35	18KΩ	COMP	1/4W 5%	01121	CB1835	27-39310-0
R36	5.6KΩ	COMP	1/4W 5%	01121	CB5625	27-39283-0
R37	750Ω	COMP	1/4W 5%	01121	CB7515	27-39309-0
SEMICONDUCTORS						
CR1		DIODE		JEDEC	1N914	27-95001-0
CR2		DIODE		JEDEC	1N914	27-95001-0
CR3		DIODE, ZENER		JEDEC	1N5235B	27-95258-0
CR4		DIODE, ZENER		JEDEC	1N5238B	27-95260-0
TRANSISTORS						
Q1				JEDEC	2N4916	29-04530-0
Q2				JEDEC	2N4916	29-04530-0
Q3				JEDEC	2N4916	29-04530-0
INTEGRATED CIRCUITS						
I.C. 1		CA3018		49671		25-08705-0
I.C. 2		CA3030		49671		25-08706-0
I.C. 3		CA3030		49671		25-08706-0

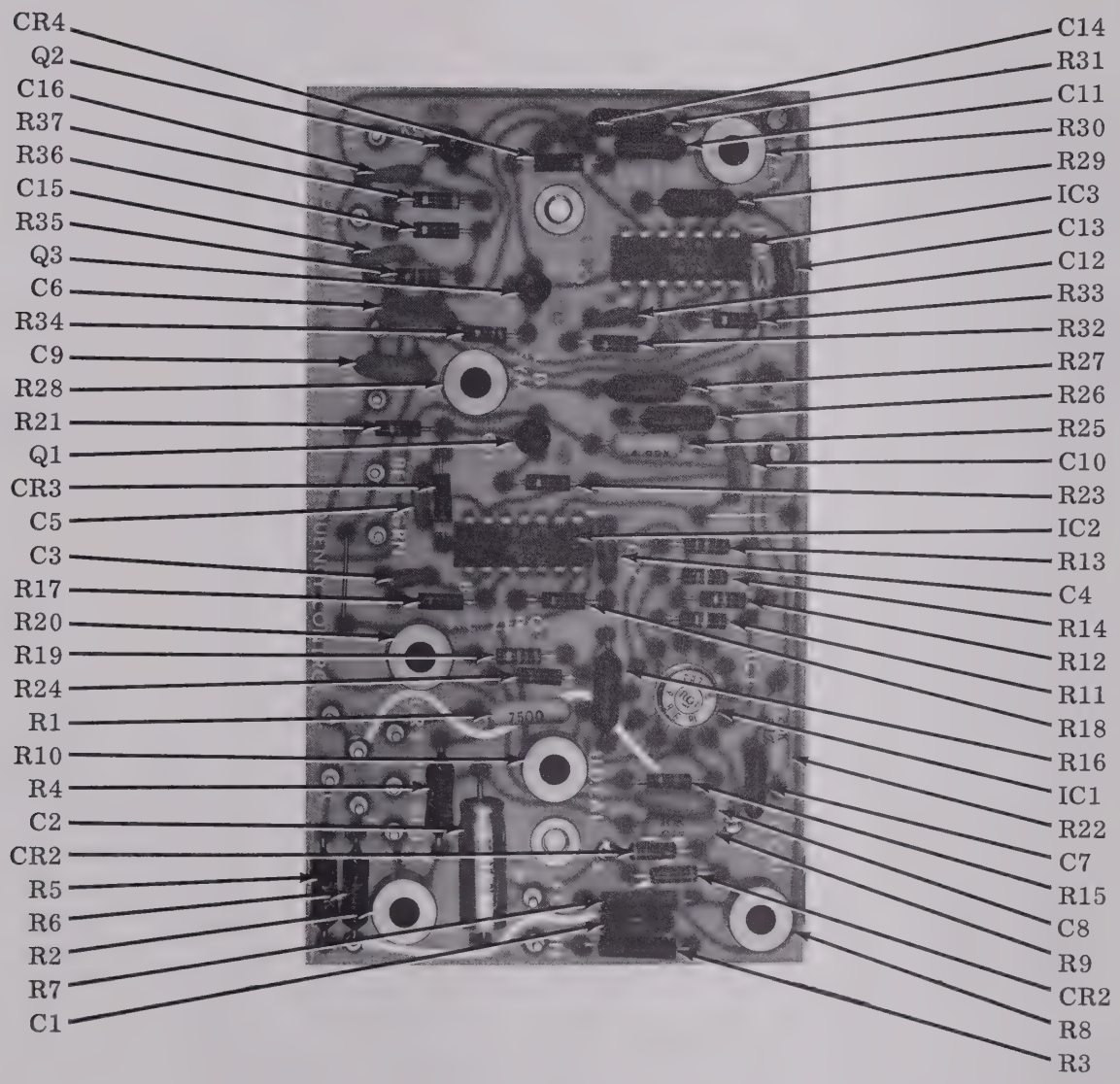
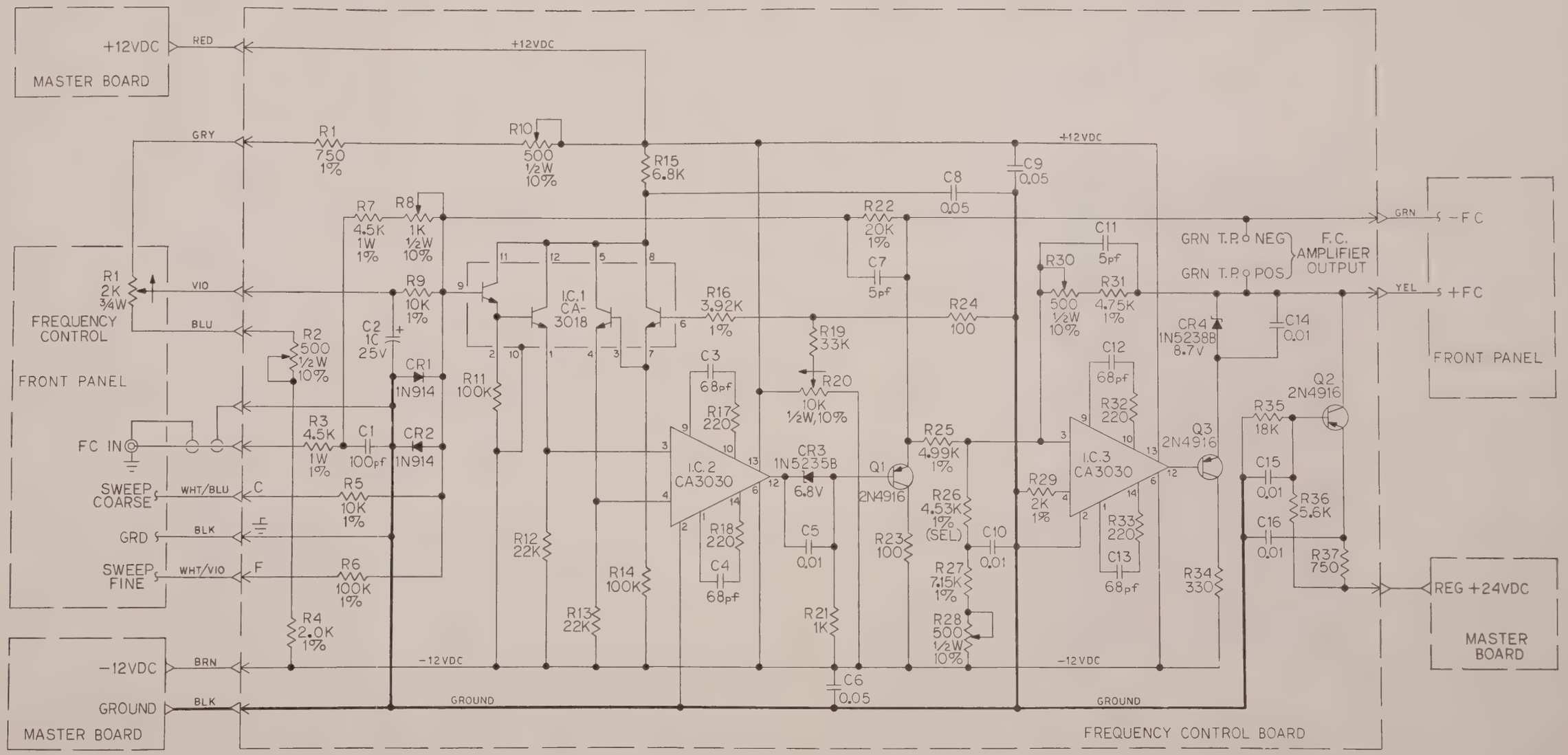


FIGURE 5-4

Frequency Control Board



NOTES~UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE ¼W, 5%.

SCHEMATIC #6
Frequency Control

PARTS LIST

DATA ROYAL ASSEMBLY: F230A MASTER BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90039-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
CAPACITORS						
C1	2700μf	ELECT	25V	56289	TE-1164	21-57200-0
C2	2700μf	ELECT	25V	56289	TE-1164	21-57200-0
C3	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C4	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C5	200pf	CER DISC	1000V	71590	DD201	21-57000-0
C6	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C7	200pf	CER DISC	1000V	71590	DD-201	21-57000-0
C8	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C9	0.05μf	CER DISC		56289	TG-S50	21-57003-0
C10	100μf	ELECT	25V	56289	TE-1211	21-57217-0
C11	100μf	ELECT	25V	56289	TE-1211	21-57217-0
C12	1300μf	ELECT	50V	56289	36D132G 050AA6B	21-57213-0
C13	1300μf	ELECT	50V	56289	36D132G 050AA6B	21-57213-0
C14	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C15	2500μf	ELECT	35V	00853	500-1954-01	21-57221-0
C16	2500μf	ELECT	35V	00853	500-1954-01	21-57221-0
C17	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C18	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C19	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C20	100μf	ELECT	25V	56289	TE-1211	21-57217-0
C21	47pf	CER DISC	1000V	56289	DD-470	21-57016-0
C22	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C23	100μf	ELECT	25V	56289	TE-1211	21-57217-0
C24	47pf	CER DISC	1000V	56289	DD-050	21-57009-0
C25	470pf	CER DISC	1000V	56289	DD-471	21-57006-0
C26	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C27	100μf	ELECT	25V	56289	TE-1211	21-57217-0
C28	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C29	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C30	100μf	ELECT	25V	56289	TE-1211	21-57217-0
C31	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C32	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C33	22pf	CER DISC	1000V	56289	DD-220	21-57012-0
C34	15pf	CER DISC	1000V	56289	DD-150	21-57017-0
C35	100μf	ELECT	25V	56289	TE-1211	21-57217-0
C36	100μf	ELECT	25V	56289	TE-1211	21-57217-0
C37	2-8pf	VAR CER		72982	538-002-89	21-63201-0
C38	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C39	5pf	CER DISC	1000V	56289	DD-050	21-57009-0
C40	2pf	MICA	500V	04062	DM-15-020D	21-57600-0
C41	0.05μf	CER DISC	50V	56289	TG-S50	21-57003-0
C42	75μf	ELECT	50V	56289	TE-1308	21-57220-0
C43	100pf	CER DISC	1000V	56289	DD-561	21-57007-0
C44	75μf	ELECT	50V	56289	TE-1308	21-57220-0
C45	75μf	ELECT	50V	56289	TE-1308	21-57220-0
C46	75μf	ELECT	50V	56289	TE-1308	21-57220-0
C47	0.047μf	MYLAR	600V	14655	WMF6547	21-57420-0
C48	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C49	0.05μf	CER DISC	50V	56289	TG-S50	21-57003-0
C50	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C51	3pf	MICA	500V	04062	DM-15-030-D	21-57628-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A MASTER BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90039-1

SCHEMATIC DESIGNATION	DESCRIPTION VALUE	DESCRIPTION TYPE	DESCRIPTION RATING	MANUFACTURER CODE	MANUFACTURER PART NO.	DATA ROYAL PART NO.
CAPACITORS (Continued)						
C52	0.05µf	CER DISC	50V	56289	TG-S50	21-57003-0
C53	10µf	TANT	20V	KEMET	K10C20K	21-57800-0
C54	0.01µf	CER DISC	50V	56289	TG-S10	21-57001-0
C55	470pf	CER DISC	1000V	56289	DD-471	21-57006-0
C56	0.01µf	CER DISC	50V	56289	TG-S10	21-57001-0
C57	470pf	CER DISC	1000V	56289	DD-471	21-57006-0
C58	10µf	TANT	20V	KEMET	K10C20K	21-57800-0
C59	10µf	TANT	20V	KEMET	K10C20K	21-57800-0
C60	10µf	TANT	20V	KEMET	K10C20K	21-57800-0
C61	3pf	MICA	500V	04062	DM15-030-D	21-57628-0
C62	2-8pf	VAR CER		72982	538-002-89	21-63201-0
C63	0.01µf	CER DISC	50V	56289	TG-S10	21-57001-0
C64	470pf	CER DISC	50V	56289	DD-471	21-57006-0
C65	0.01µf	CER DISC	50V	56289	TG-S10	21-57001-0
C66	2pf	MICA	500V	04062	DM-15-020D	21-57600-0
C67	100µf	ELECT	25V	56289	TE-1211	21-57217-0
C68	0.01µf	CER DISC	50V	56289	TG-S10	21-57001-0
C69	100µf	ELECT	25V	56289	TE-1211	21-57217-0
C70	0.01µf	CER DISC	50V	56289	TG-S10	21-57001-0
RESISTORS						
R1	0.51Ω	WW	2W 5%	01121	HB51G5	27-48013-0
R2	680Ω	COMP	1/4W 5%	01121	CB6815	27-39271-0
R3	330Ω	COMP	1/4W 5%	01121	CB3315	27-39267-0
R4	330Ω	COMP	1/4W 5%	01121	CB3315	27-39267-0
R5	680Ω	COMP	1/4W 5%	01121	CB6815	27-39271-0
R6	0.51Ω	WW	2W 5%	01121	HB51G5	27-48013-0
R7	300Ω	COMP	1/4W 5%	01121	CB3015	27-39266-0
R8	300Ω	COMP	1/4W 5%	01121	CB3015	27-39266-0
R9	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R10	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R11	1MΩ	COMP	1/4W 5%	01121	CB1055	27-39299-0
R12	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R13	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R14	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R15	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R16	1.65KΩ	FILM	1/4W 1%	12126	M1/4-1.65K	27-42857-0
R17	1.65KΩ	FILM	1/4W 1%	12126	M1/4-1.65K	27-42857-0
R18	4.99KΩ	FILM	1/4W 1%	12126	M1/4-4.99K	27-42887-0
R19	2.55KΩ	FILM	1/4W 1%	12126	M1/4-2.55K	27-42865-0
R20	1KΩ	VAR	1/2W 10%	01121	SV1021	27-49500-0
R21	3.32KΩ	FILM	1/4W 1%	12126	M1/4-3.32K	27-42872-0
R22	3.32KΩ	FILM	1/4W 1%	12126	M1/4-3.32K	27-42872-0
R23	3.32KΩ	FILM	1/4W 1%	12126	M1/4-3.32K	27-42872-0
R24	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R25	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R26	2.2KΩ	COMP	1/4W 5%	01121	CB2225	27-39278-0
R27	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R28	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R29	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A MASTER BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90039-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
RESISTORS (Continued)						
R30	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R31	390Ω	COMP	1/4W 5%	01121	CB3915	27-39268-0
R32	390Ω	COMP	1/4W 5%	01121	CB3915	27-39268-0
R33	2.2KΩ	COMP	1/4W 5%	01121	CB2225	27-39278-0
R34	3.3KΩ	COMP	1/4W 5%	01121	CB3325	27-39280-0
R35	22Ω	COMP	1/4W 5%	01121	CB2205	27-39253-0
R36	2KΩ	COMP	1/4W 5%	01121	CB2025	27-39277-0
R37	39Ω	COMP	1/4W 5%	01121	CB3905	27-39256-0
R38	2KΩ	COMP	1/4W 5%	01121	CB2025	27-39277-0
R39	22Ω	COMP	1/4W 5%	01121	CB2205	27-39253-0
R40	3.3KΩ	COMP	1/4W 5%	01121	CB3325	27-39280-0
R41	56Ω	COMP	1/4W 5%	01121	CB5605	27-39302-0
R42	56Ω	COMP	1/4W 5%	01121	CB5605	27-39302-0
R43	2.1KΩ	FILM	1/4W 1%	12126	M1/4-2.1K	27-42861-0
R44	1KΩ	VAR	1/2W 10%	01121	SV1025	27-49500-0
R45	3.92KΩ	FILM	1/4W 1%	12126	M1/4-3.92K	27-42878-0
R46	3.92KΩ	FILM	1/4W 1%	12126	M1/4-3.92K	27-42878-0
R47	1KΩ	VAR	1/2W 10%	01121	SV1025	27-49500-0
R48	2.1KΩ	FILM	1/4W 1%	12126	M1/4-2.1K	27-42861-0
R49	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R50	47Ω	COMP	1/4W 5%	01121	CB4705	27-39257-0
R51	47Ω	COMP	1/4W 5%	01121	CB4705	27-39257-0
R52	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R53	100KΩ	COMP	1/4W 5%	01121	CB1045	27-39294-0
R54	86.6Ω	FILM	1/4W 1%	12126	M1/4-86.6	27-42779-0
R55	121Ω	FILM	1/4W 1%	12126	M1/4-121	27-42787-0
R56	301Ω	FILM	1/4W 1%	12126	M1/4-301	27-42804-0
R57	60.4Ω	FILM	1/4W 1%	12126	M1/4-60.4	27-42771-0
R58	500Ω	VAR	1/2W 10%	01121	SV5011	27-49512-0
R59	301Ω	FILM	1/4W 1%	12126	M1/4-301	27-42804-0
R60	390Ω	COMP	1/4W 5%	01121	CB3915	27-39268-0
R61	499Ω	FILM	1/4W 1%	12126	M1/4-499	27-42821-0
R62	12.1KΩ	FILM	1/4W 1%	12126	M1/4-12.1K	27-42916-0
R63	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R64	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R65	2.21KΩ	FILM	1/4W 1%	12126	M1/4-2.21K	27-42863-0
R66	2.1KΩ	FILM	1/4W 1%	12126	M1/4-2.1K	27-42861-0
R67	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R68	2.7KΩ	COMP	1/4W 5%	01121	CB2725	27-39279-0
R69	270KΩ	COMP	1/4W 5%	01121	CB2715	27-39303-0
R70	2.7KΩ	COMP	1/4W 5%	01121	CB2725	27-39279-0
R71	47Ω	COMP	1/4W 5%	01121	CB4705	27-39257-0
R72	47Ω	COMP	1/4W 5%	01121	CB4705	27-39257-0
R73	2.7KΩ	COMP	1/4W 5%	01121	CB2725	27-39279-0
R74	10KΩ	VAR	1/2W 10%	01121	SV1031	27-49513-0
R75	68KΩ	COMP	1/4W 5%	01121	CB6835	27-39292-0
R76	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R77	2.7KΩ	COMP	1/4W 5%	01121	CB2725	27-39279-0
R78	22Ω	COMP	1/4W 5%	01121	CB2205	27-39253-0
R79	3.32KΩ	FILM	1/4W 1%	12126	M1/4-3.32K	27-42872-0
R80	1KΩ	VAR	1/2W 10%	01121	SV1021	27-49500-0
R81	4.12KΩ	FILM	1/4W 1%	12126	M1/4-4.12K	27-42880-0
R82	22Ω	COMP	1/4W 5%	01121	CB2205	27-39253-0
R83	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A MASTER BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90039-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
RESISTORS (Continued)						
R84	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R85	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R86	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R87	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R88	50Ω	VAR	1/2W 10%	01121	SV5001	27-49514-0
R89	115Ω	FILM	1/4W 1%	12126	M1/4-115	27-42786-0
R90	3.01KΩ	FILM	1/4W 1%	12126	M1/4-3.01K	27-42869-0
R91	49.9Ω	FILM	1/4W 1%	12126	M1/4-49.9	27-42787-0
R92	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R93	5.6KΩ	COMP	1/4W 5%	01121	CB5625	27-39283-0
R94	15Ω	COMP	1/4W 5%	01121	CB1505	27-39252-0
R95	15Ω	COMP	1/4W 5%	01121	CB1505	27-39252-0
R96	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R97	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R98	1.5Ω	COMP	1/2W 5%	01121	EB15G5	27-39508-0
R99	820Ω	COMP	1/4W 5%	01121	CB8215	27-39272-0
R100	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R101	82Ω	COMP	1/4W 5%	01121	CB8205	27-39260-0
R102	107Ω	FILM	1/4W 1%	12126	M1/4-107	27-42785-0
R103	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R104	10KΩ	VAR	1/2W 10%	01121	SV1031	27-49513-0
R105	1.5Ω	COMP	1/2W 5%	01121	EB15G5	27-39508-0
R106	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R107	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R108	180Ω	COMP	1/4W 5%	01121	CB1815	27-39264-0
R109	150Ω	COMP	1/4W 5%	01121	CB1515	27-39263-0
R110	750Ω	COMP	1W 5%	01121	GB7515	27-40006-0
R111	750Ω	COMP	1W 5%	01121	GB7515	27-40006-0
R112	1.5Ω	COMP	1/2W 5%	01121	EB15G5	27-39508-0
R113	150Ω	COMP	2W 5%	01121	HB1515	27-40251-0
R114	12Ω	COMP	1/2W 5%	01121	EB1205	27-39510-0
R115	150Ω	COMP	2W 5%	01121	HB1515	27-40251-0
R116	12Ω	COMP	1/2W 5%	01121	EB1205	27-39510-0
R117	150Ω	COMP	2W 5%	01121	HB1515	27-40251-0
R118	1.5Ω	COMP	1/2W 5%	01121	EB15G5	27-39508-0
R119	51Ω	COMP	1/4W 5%	01121	CB5105	27-39258-0
R120	51Ω	COMP	1/4W 5%	01121	CB5105	27-39258-0
R121	51Ω	COMP	1/4W 5%	01121	CB5105	27-39258-0
R122	51Ω	COMP	1/4W 5%	01121	CB5105	27-39258-0
R123	49.9Ω	FILM	1/4W 1%	12126	M1/4-49.9	27-42764-0
R124	51Ω	COMP	1/4W 5%	01121	CB5105	27-39258-0
R125	150Ω	FILM	1/4W 1%	12126	M1/4-150	27-42793-0
R126	37.4Ω	FILM	1/4W 1%	07115	NA60-3740F	27-42990-0
R127	150Ω	FILM	1/4W 1%	12126	M1/4-150	27-42793-0
R128	1KΩ	VAR	1/2W 10%	01121	SV1021	27-49500-0
R129	1KΩ	VAR	1/2W 10%	01121	SV1021	27-49500-0
R130	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R131	3.32KΩ	FILM	1/4W 1%	12126	M1/4-3.32K	27-42872-0
R132	1KΩ	FILM	1/4W 1%	12126	M1/4-1K	27-42846-0
R133	1KΩ	FILM	1/4W 1%	12126	M1/4-1K	27-42846-0
R134	1KΩ	VAR	1/2W 10%	01121	SV1021	27-49500-0
R135	1KΩ	VAR	1/2W 10%	01121	SV1021	27-49500-0
R136	4.99KΩ	FILM	3/4W 1%	12126	M3/4-4.99K	27-44254-0
R137	4.99KΩ	FILM	3/4W 1%	12126	M3/4-4.99K	27-44254-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A MASTER BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90039-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
RESISTORS (Continued)						
R138	12.1KΩ	FILM	1/4W 1%	12126	M1/4-12.1K	27-42916-0
R139	4.99KΩ	FILM	1/4W 1%	12126	M1/4-4.99K	27-42887-0
R140	220KΩ	COMP	1/4W 5%	01121	CB2245	27-39295-0
R141	390Ω	COMP	1/4W 5%	01121	CB3915	27-39268-0
R142	4.7KΩ	COMP	1/4W 5%	01121	CB4725	27-39282-0
R143	2.2KΩ	COMP	1/4W 5%	01121	CB2225	27-39278-0
R144	1.10KΩ	FILM	1/4W 1%	12126	M1/4-1.10K	27-42983-0
R145	68Ω	COMP	1W 5%	01121	GB6805	27-40008-0
R146	1.15KΩ	FILM	1/4W 1%	07115	NA60-1151F	27-42848-0
R147	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R148	1.2KΩ	COMP	1/4W 5%	01121	CB1225	27-39274-0
R149	10MΩ	COMP	1/4W 5%	01121	CB1065	27-39321-0
R150	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R151	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R152	3.9KΩ	COMP	1/4W 5%	01121	CB3925	27-39281-0
R153	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R154	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R155	5.6KΩ	COMP	1/4W 5%	01121	CB5625	27-39283-0
R156	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R157	5.6KΩ	COMP	1/4W 5%	01121	CB5625	27-39283-0
R158	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R159	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R160	2.2KΩ	COMP	1/4W 5%	01121	CB2225	27-39278-0
R161	1KΩ	FILM	1/4W 1%	12126	M1/4-1K	27-42846-0
R162	3.74KΩ	FILM	1/4W 1%	07115	NA60-3741F	27-42876-0
R163	500Ω	VAR	1/2W 10%	01121	SV5011	27-49512-0
R164	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R165	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R166	33Ω	COMP	1/4W 5%	01121	CB3305	27-39255-0
R167	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R168	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R169	1.8KΩ	COMP	1/4W 5%	01121	CB1825	27-39276-0
R170	6.8KΩ	COMP	1/4W 5%	01121	CB6825	27-39284-0
R171	6.8KΩ	COMP	1/4W 5%	01121	CB6825	27-39284-0
R172	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R173	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R174	220KΩ	COMP	1/4W 5%	01121	CB2245	27-39295-0
R175	665Ω	FILM	1/4W 1%	07115	NA60-6650E	27-42830-0
R176	10KΩ	VAR	1/2W 10%	01121	SV1035	27-49513-0
R177	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R178	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R179	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R180	27Ω	COMP	1/4W 5%	01121	CB2705	27-39254-0
R181	1.2KΩ	COMP	1/4W 5%	01121	CB1225	27-39274-0
R182	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R183	22Ω	COMP	1/4W 5%	01121	CB2205	27-39253-0
R184	22Ω	COMP	1/4W 5%	01121	CB2205	27-39253-0
R185	220Ω	COMP	1/4W 5%	01121	CB2215	27-39265-0
R186	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R187	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R188	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R189	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A MASTER BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90039-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
SEMICONDUCTORS						
CR1		DIODE		14099	SCE-2	27-95000-0
CR2		DIODE		14099	SCE-2	27-95000-0
CR3		DIODE		14099	SCE-2	27-95000-0
CR4		DIODE		14099	SCE-2	27-95000-0
CR5		DIODE		JEDEC	1N914	27-95001-0
CR6		DIODE		JEDEC	1N914	27-95001-0
CR7		DIODE		JEDEC	1N914	27-95001-0
CR8		DIODE		14099	SCE-2	27-95000-0
CR9		DIODE		14099	SCE-2	27-95000-0
CR10		DIODE		14099	SCE-2	27-95000-0
CR11		DIODE		14099	SCE-2	27-95000-0
CR12		ZENER DIODE		JEDEC	1N5252	27-95261-0
CR13		DIODE		14099	SCE-2	27-95000-0
CR14		DIODE		14099	SCE-2	27-95000-0
CR15		DIODE		14099	SCE-2	27-95000-0
CR16		DIODE		14099	SCE-2	27-95000-0
CR17		DIODE		JEDEC	1N914	27-95001-0
CR18		DIODE		JEDEC	1N914	27-95001-0
CR19		DIODE		JEDEC	1N914	27-95001-0
CR20		ZENER DIODE		JEDEC	1N5232	27-95250-0
CR21		DIODE		JEDEC	1N914	27-95001-0
CR22		DIODE		JEDEC	1N914	27-95001-0
CR23		ZENER DIODE		JEDEC	1N252	27-95261-0
CR24		ZENER DIODE		JEDEC	1N5242	27-95259-0
CR25		DIODE		JEDEC	1N914	27-95001-0
CR26		DIODE		JEDEC	1N914	27-95001-0
CR27		ZENER DIODE		JEDEC	1N5250	27-95264-0
CR28		ZENER DIODE		JEDEC	1N5227B	27-95263-0
CR29		DIODE		JEDEC	1N914	27-95001-0
CR30		DIODE		JEDEC	1N914	27-95001-0
CR31		DIODE		JEDEC	1N914	27-95001-0
CR32		DIODE		JEDEC	1N914	27-95001-0
CR33		ZENER DIODE		JEDEC	1N5234	27-95251-0
CR34		DIODE		JEDEC	1N914	27-95001-0
CR35		DIODE		JEDEC	1N914	27-95001-0
CR36		DIODE		JEDEC	1N914	27-95001-0
CR37		DIODE		JEDEC	1N914	27-95001-0
CR38		DIODE		JEDEC	1N914	27-95001-0
CR39		DIODE		JEDEC	1N914	27-95001-0
CR40		DIODE		JEDEC	1N914	27-95001-0
CR41		DIODE		JEDEC	1N914	27-95001-0
CR42		DIODE		JEDEC	1N914	27-95001-0
TRANSISTORS						
Q1				JEDEC	2N2218	29-04500-0
Q2				JEDEC	2N4916	29-04530-0
Q3				JEDEC	2N2218	29-04500-0
Q4				JEDEC	2N4898	29-04510-0
Q5		40468		49671		29-04516-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A MASTER BOARD ASSEMBLY — DATA ROYAL PART NO. 29-90039-1

SCHEMATIC DESIGNATION	DESCRIPTION VALUE	DESCRIPTION TYPE	DESCRIPTION RATING	MANUFACTURER CODE	MANUFACTURER PART NO.	DATA ROYAL PART NO.
TRANSISTORS (Continued)						
Q6				JEDEC	2N4360	29-04513-0
Q7		40250		49671		29-04515-0
Q8				JEDEC	2N2218	29-04500-0
Q9				JEDEC	2N4916	29-04530-0
Q10				JEDEC	2N2218	29-04500-0
Q11				JEDEC	2N4258	29-04507-0
Q12				JEDEC	2N4274	29-04508-0
Q13				JEDEC	2N3638	29-04503-0
Q14				JEDEC	2N2218	29-04500-0
Q15				JEDEC	2N4916	29-04530-0
Q16		40235		49671		29-04532-0
Q17				JEDEC	2N3640	29-04504-0
Q18				JEDEC	2N3640	29-04504-0
Q19		40235		49671		29-04532-0
Q20				JEDEC	2N4916	29-04530-0
Q21				JEDEC	2N5160	29-04525-0
Q22				JEDEC	2N3866	29-04522-0
Q23				JEDEC	2N4890	29-04524-0
Q24				JEDEC	2N3640	29-04504-0
Q25				JEDEC	2N2218	29-04500-0
Q26		40235		49671		29-04532-0
Q27				JEDEC	2N4916	29-04530-0
Q28		40235		49671		29-04532-0
Q29				JEDEC	2N4916	29-04530-0
Q30				JEDEC	2N3638	29-04503-0
INTEGRATED CIRCUITS						
I. C. 1		μA709C		17227		25-08700-0
I. C. 2		μA709C		17227		25-08700-0
I. C. 3		CA3018		49671		25-08705-0
I. C. 4		CA3018		49671		25-08705-0
I. C. 5		μA710C		17227		25-08701-0
I. C. 6		SN74H10N		01295		25-08708-0
I. C. 7		SN74H10N		01295		25-08708-0
I. C. 8		SN74H71N		01295		25-08709-0
I. C. 9		CA3018		49671		25-08705-0

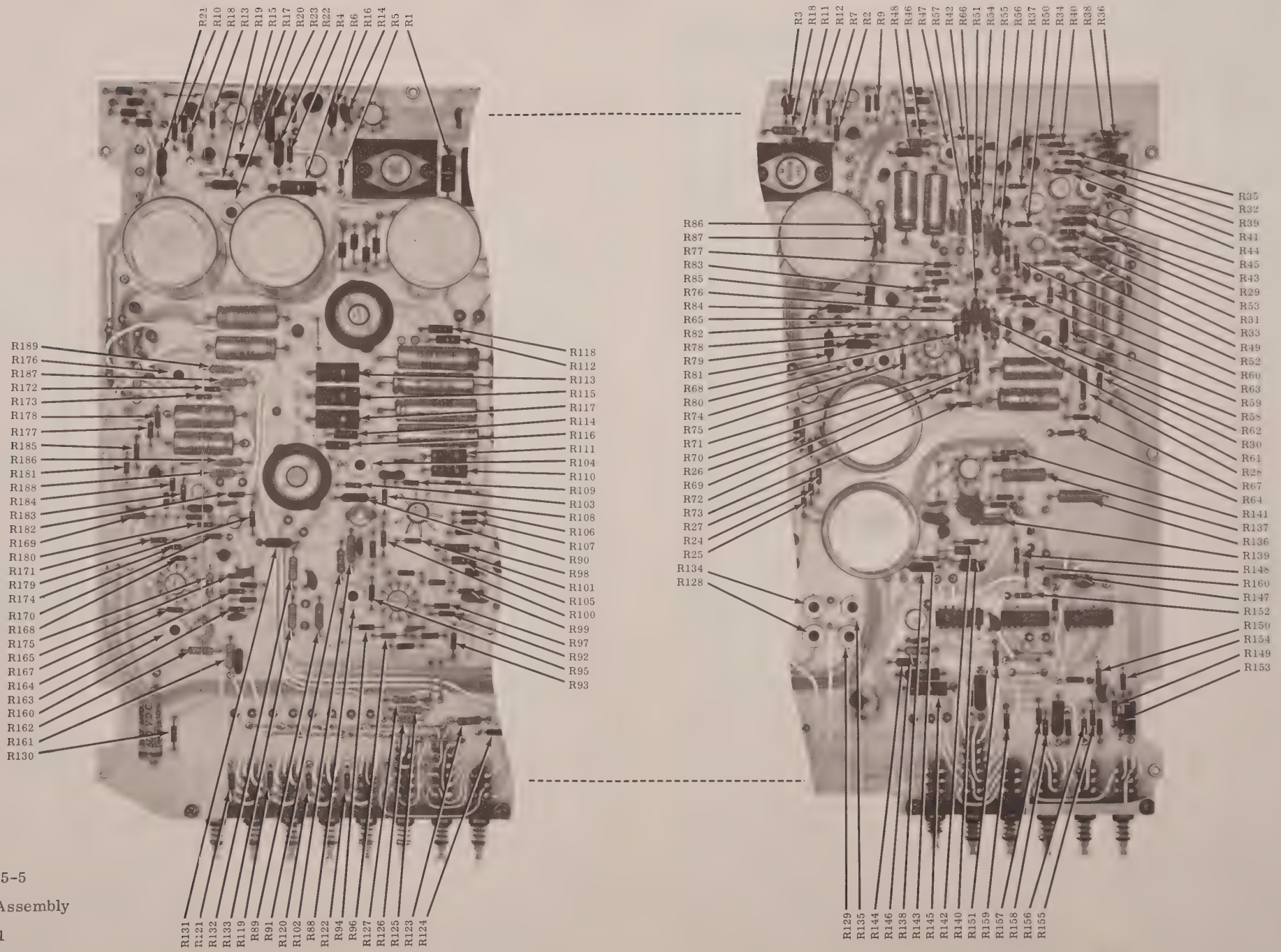


FIGURE 5-5

Master Board Assembly

Sheet 1

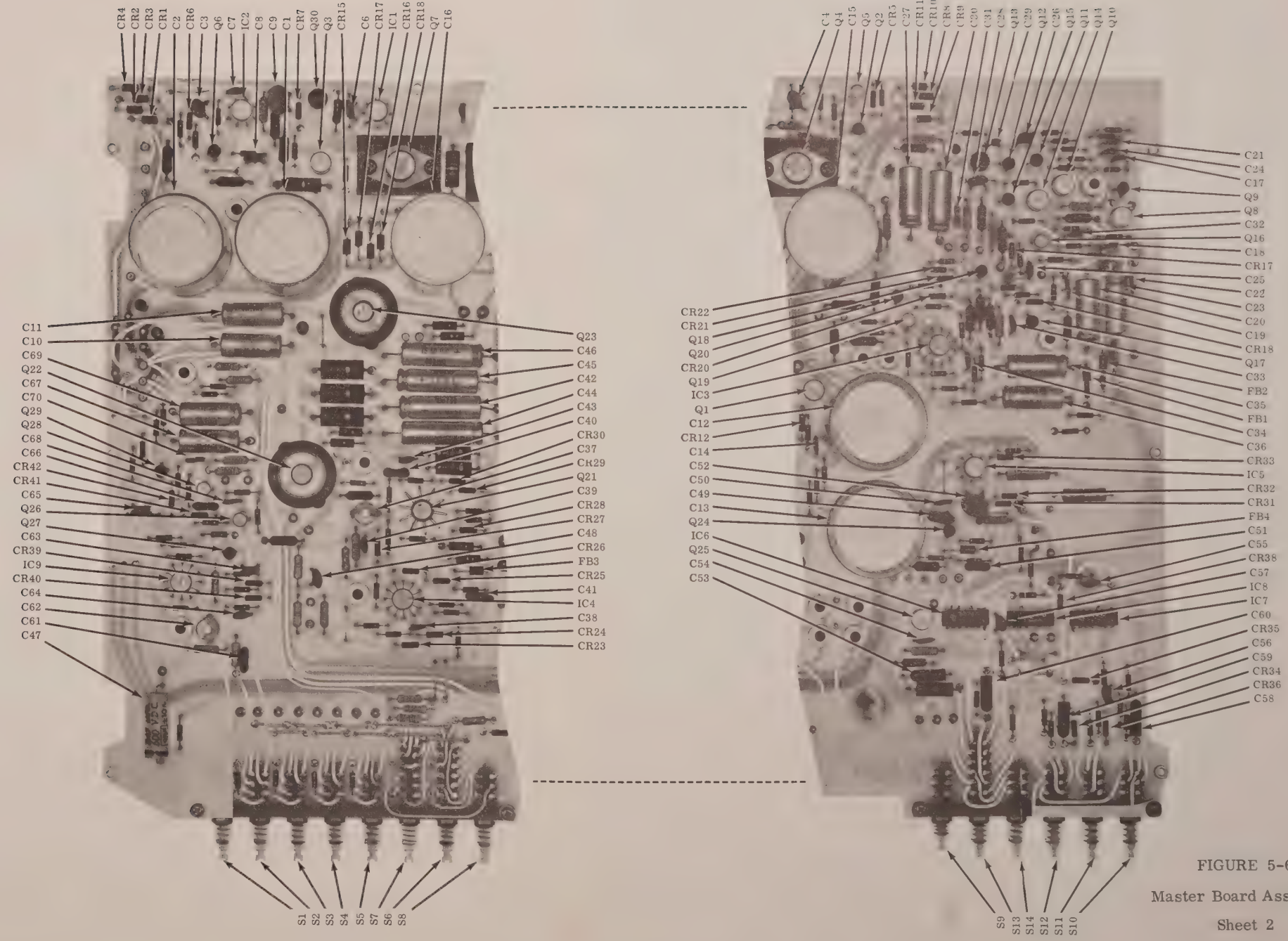
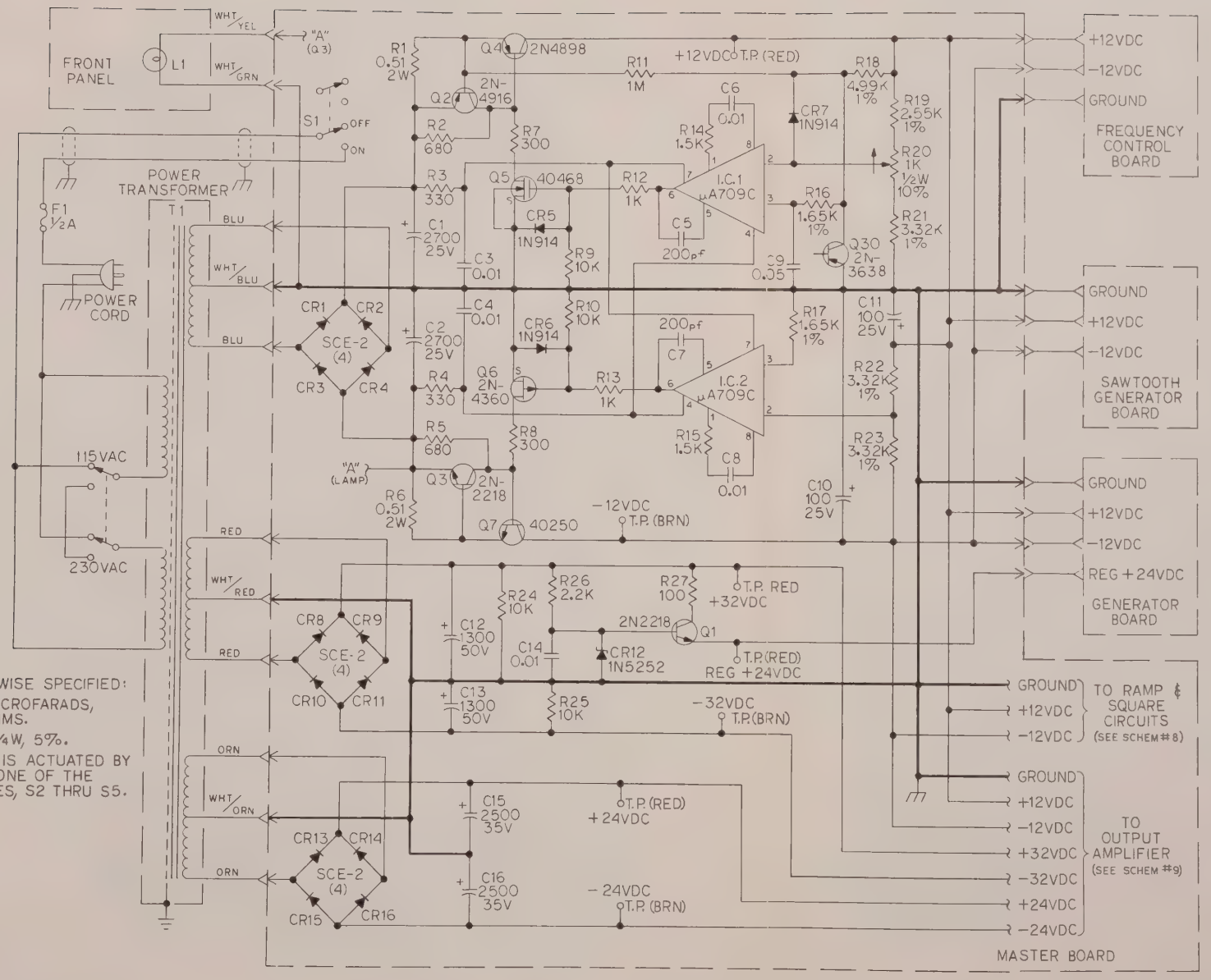


FIGURE 5-6

Master Board Assembly

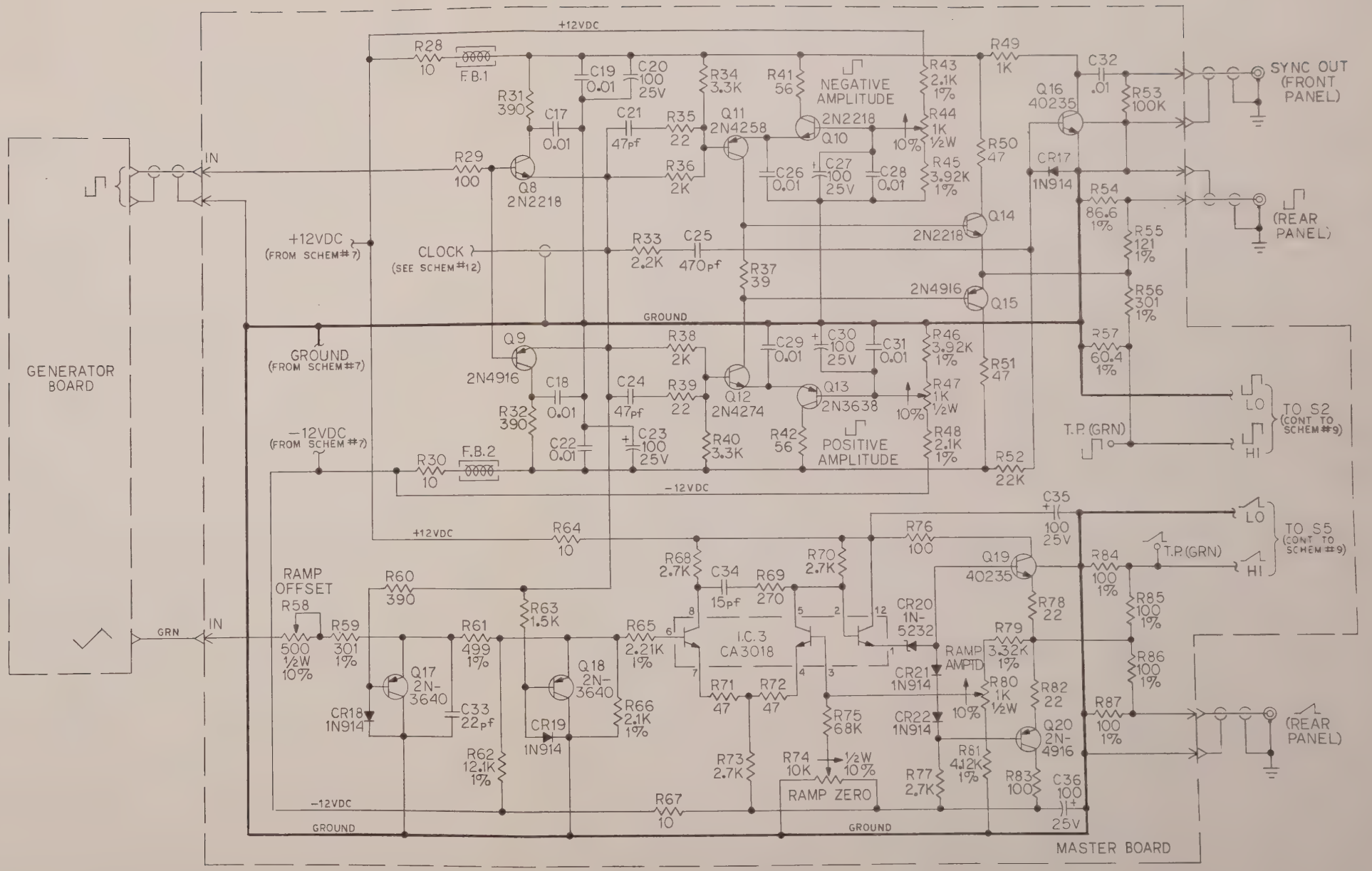
Sheet 2



NOTES~UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE ¼W, 5%.
3. POWER SWITCH, S1, IS ACTUATED BY DEPRESSING ANY ONE OF THE FUNCTION SWITCHES, S2 THRU S5.

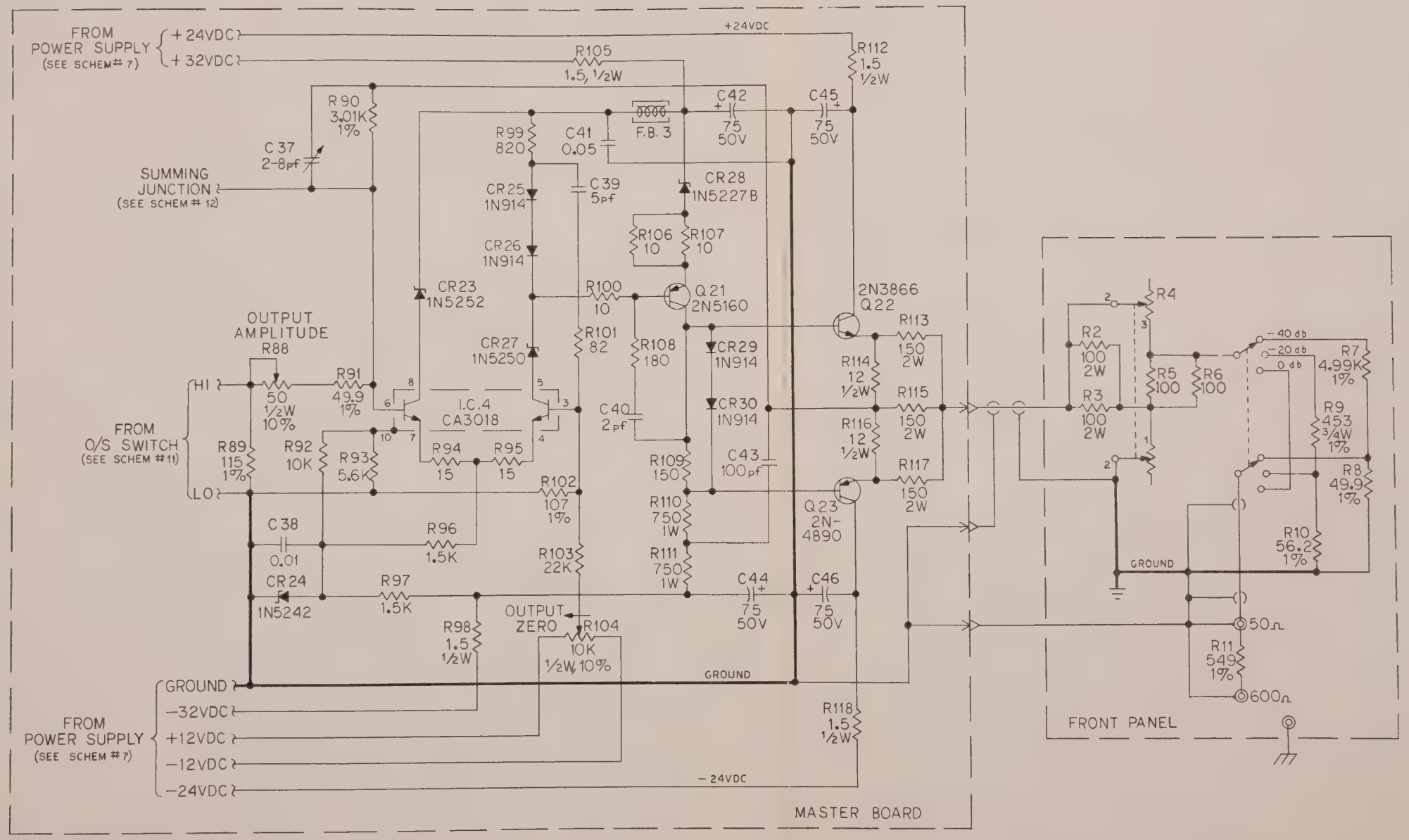
SCHEMATIC #7
Power Supply



NOTES~UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE ¼W, 5%.

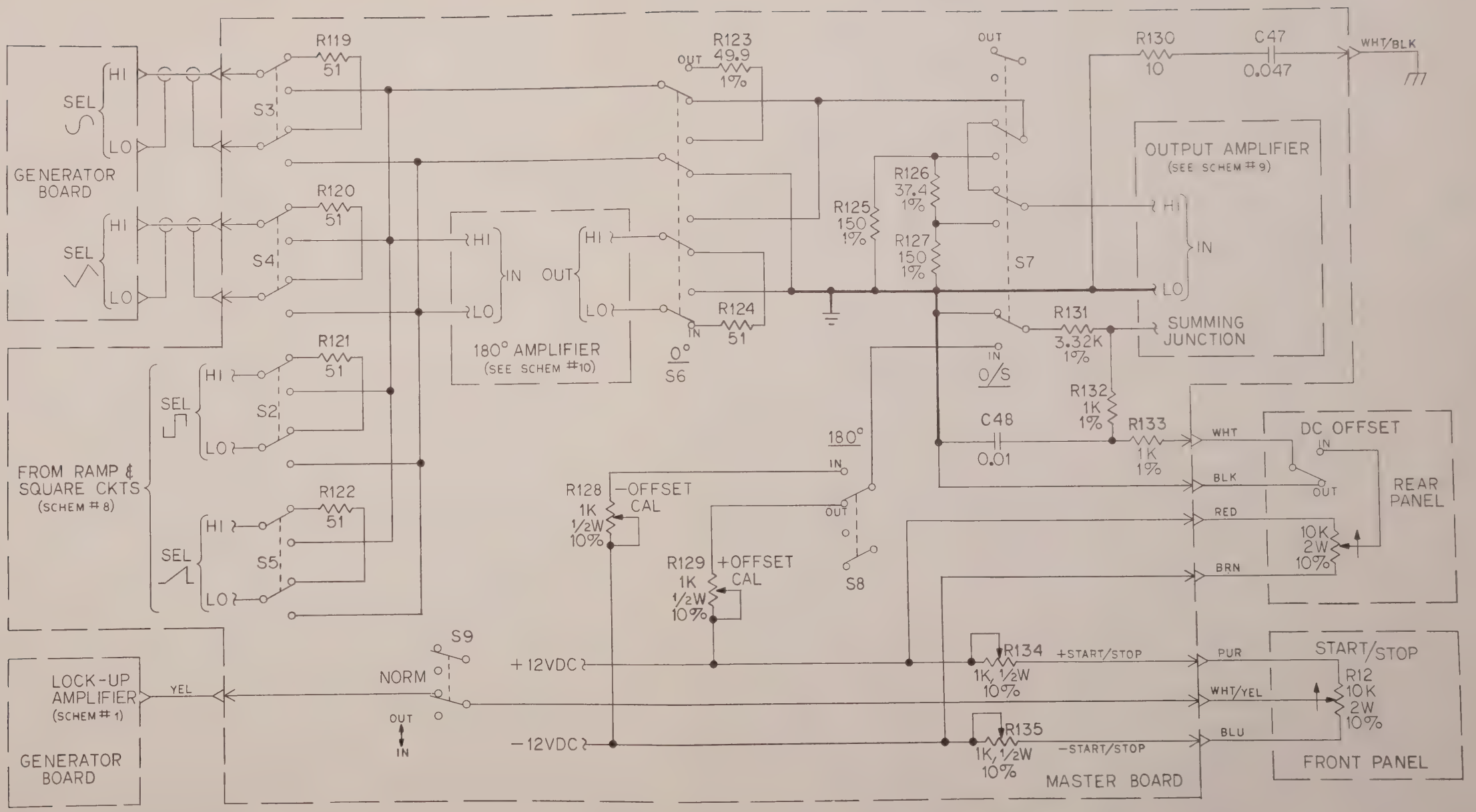
SCHEMATIC #8
Square & Ramp Circuits



NOTES~UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE 1/4W, 5%.

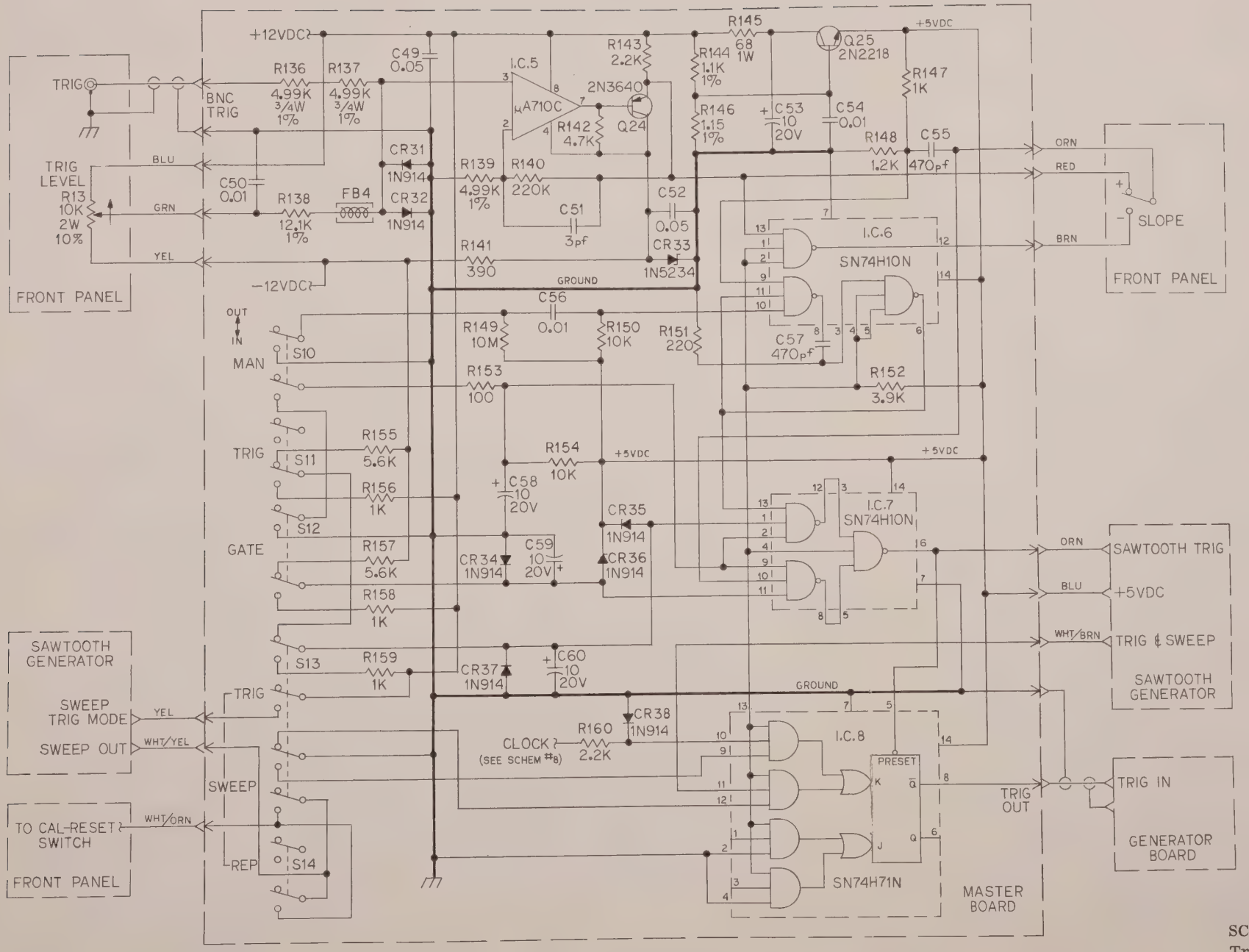
SCHEMATIC #9
Output Amplifier



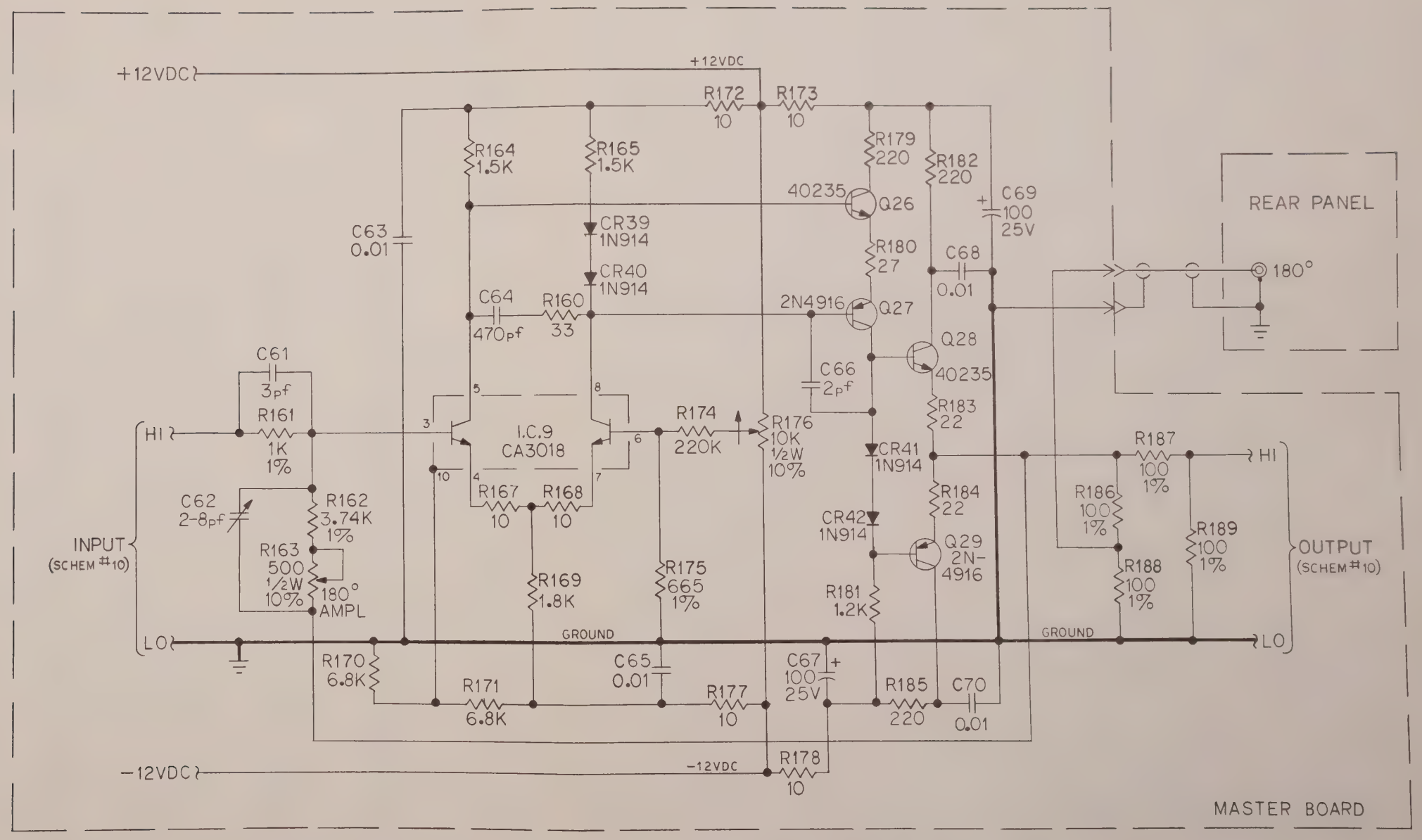
NOTES~UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE 1/4W, 5%.

SCHEMATIC #10
Push Button Circuits



SCHEMATIC #11
Trigger Circuits



NOTES~ UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE 1/4W, 5%.

SCHEMATIC #12
180° Amplifier

PARTS LIST

DATA ROYAL ASSEMBLY: F230A SAWTOOTH GENERATOR BOARD — DATA ROYAL PART NO. 29-90042-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
CAPACITORS						
C1	4.95μf	MYLAR	100V	27556	ZPB-4954F	21-57401-0
C2	4.95μf	MYLAR	100V	27556	ZPB-4954F	21-57401-0
C3		SELECTED				
C4	0.099μf	MYLAR	50V	27556	PA1A993F	21-57700-0
C5		SELECTED				
C6	1000pf	MICA	100V	04062	DM-15-102F	21-57612-0
C7	5pf	MICA	500V	04062	DM-15-050D	21-57626-0
C8	0.05μf	CER DISC	50V	56289	TG-S50	21-57003-0
C9	0.05μf	CER DISC	50V	56289	TG-S50	21-57003-0
C10	0.001μf	CER DISC	1000V	71590	DD-102	21-57021-0
C11	0.001μf	CER DISC	1000V	71590	DD-102	21-57021-0
C12	100pf	CER DISC	1000V	56289	DD-101	21-57007-0
C13	100μf	ELECT	25V	56289	TE-1211	21-57217-0
C14	100μf	ELECT	25V	56289	TE1211	21-57217-0
C15	200pf	MICA	500V	04062	DM-15-150J	21-57633-0
C16		SELECTED				
C17		SELECTED				
C18	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C19	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C20	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C21	0.01μf	CER DISC	50V	56289	TG-S10	21-57001-0
C22	10μf	TANT	20V	KEMET	K10C20K	21-57800-0
C23	10μf	TANT	20V	KEMET	K10C20K	21-57800-0
C24	22pf	CER DISC	1000V	71590	DD-220	21-57012-0
C25	27pf	CER DISC	1000V	71590	DD-270	21-57020-0
C26	0.05μf	CER DISC	50V	56289	TG-S50	21-57003-0
C27	5pf	MICA	500V	04062	DM15-050K	21-57626-0
RESISTORS						
R1	9.1MΩ	COMP	1/2W 5%	01121	EB9155	27-39518-0
R2	10MΩ	COMP	1/2W 5%	01121	EB1065	27-39517-0
R3	1MΩ	FILM	1/4W 1%	07115	NA60-1004F	27-42967-0
R4	1MΩ	FILM	1/4W 1%	07115	NA60-1004F	27-42967-0
R5	200KΩ	FILM	1/4W 1%	12126	M1/4-200K	27-42989-0
R6	14.3KΩ	FILM	1/4W 1%	12126	M1/4-14.3K	27-42988-0
R7	4.99KΩ	FILM	1/4W 1%	12126	M1/4-4.99K	27-42887-0
R8	49.9Ω	FILM	1/4W 1%	12126	M1/4-49.9	27-42764-0
R9	500Ω	VAR	1/2W 10%	01121	SV5011	27-49512-0
R10	12KΩ	COMP	1/4W 5%	01121	CB1235	27-39287-0
R11	1.8KΩ	COMP	1/4W 5%	01121	CB1825	27-39276-0
R12	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R13	18KΩ	COMP	1/4W 5%	01121	CB1835	27-39310-0
R14	18KΩ	COMP	1/4W 5%	01121	CB1835	27-39310-0
R15	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R16	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R17	510Ω	COMP	1/4W 5%	01121	CB5115	27-39314-0
R18	510Ω	COMP	1/4W 5%	01121	CB5115	27-39314-0
R19	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R20	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A SAWTOOTH GENERATOR BOARD — DATA ROYAL PART NO. 29-90042-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
RESISTORS (Continued)						
R21	2.2KΩ	COMP	1/4W 5%	01121	CB2225	27-39278-0
R22	22KΩ	COMP	1/4W 5%	01121	CB2235	27-39288-0
R23	5.6KΩ	COMP	1/4W 5%	01121	CB5625	27-39283-0
R24	5.6KΩ	COMP	1/4W 5%	01121	CB5625	27-39283-0
R25	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R26	100Ω	VAR	1/2W 10%	01121	SV1011	27-49510-0
R27	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R28	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R29	27Ω	COMP	1/4W 5%	01121	CB2705	27-39254-0
R30	1.2KΩ	COMP	1/4W 5%	01121	CB1225	27-39274-0
R31	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R32	47Ω	COMP	1/4W 5%	01121	CB1205	27-39251-0
R33	22Ω	COMP	1/4W 5%	01121	CB2205	27-39253-0
R34	22Ω	COMP	1/4W 5%	01121	CB2205	27-39253-0
R35	470Ω	COMP	1/4W 5%	01121	CB4715	27-39269-0
R36	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R37	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R38	100Ω	FILM	1/4W 1%	12126	M1/4-100	27-42784-0
R39	6.8KΩ	COMP	1/4W 5%	01121	CB6825	27-39284-0
R40	1KΩ	VAR	1/2W 10%	01121	SV1025	27-49500-0
R41	6.8KΩ	COMP	1/4W 5%	01121	CB6825	27-39284-0
R42	500Ω	VAR	1/2W 10%	01121	SV5011	27-49512-0
R43	226Ω	FILM	1/4W 1%	12126	M1/4-226	27-42991-0
R44	2KΩ	FILM	1/4W 1%	12126	M1/4-2K	27-42860-0
R45	1KΩ	FILM	1/4W 1%	12126	M1/4-1K	27-42846-0
R46	1KΩ	FILM	1/4W 1%	12126	M1/4-1K	27-42846-0
R47	2.1KΩ	FILM	1/4W 1%	12126	M1/4-2.1K	27-42861-0
R48	500Ω	VAR	1/2W 10%	01121	SV5011	27-49512-0
R49	10 Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R50	10KΩ	VAR	1/2W 10%	01121	SV1031	27-49513-0
R51	10Ω	COMP	1/4W 5%	01121	CB1005	27-39250-0
R52	100KΩ	COMP	1/4W 5%	01121	CB1045	27-39294-0
R53	499Ω	FILM	1/4W 1%	12126	M1/4-499	27-42821-0
R54	698Ω	FILM	1/4W 1%	12126	M1/4-698	27-42832-0
R55	33Ω	COMP	1/4W 5%	01121	CB3305	27-39255-0
R56	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R57	3.9KΩ	COMP	1/4W 5%	01121	CB3925	27-39281-0
R58	68Ω	COMP	1/4W 5%	01121	CB6805	27-39259-0
R59	910Ω	COMP	1/4W 5%	01121	CB9115	27-39315-0
R60	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R61	3.9KΩ	COMP	1/4W 5%	01121	CB3925	27-39281-0
R62	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R63	10KΩ	COMP	1/4W 5%	01121	CB1035	27-39286-0
R64	3.3KΩ	COMP	1/4W 5%	01121	CB3325	27-39280-0
R65	330Ω	COMP	1/4W 5%	01121	CB3315	27-39267-0
R66	47Ω	COMP	1/4W 5%	01121	CB1205	27-39251-0
R67	1.5KΩ	COMP	1/4W 5%	01121	CB1525	27-39275-0
R68	1.8KΩ	COMP	1/4W 5%	01121	CB1825	27-39276-0
R69	1KΩ	COMP	1/4W 5%	01121	CB1025	27-39273-0
R70	2.2KΩ	COMP	1/4W 5%	01121	CB2225	27-39278-0
R71	8.2KΩ	COMP	1/4W 5%	01121	CB8225	27-39285-0
R72	33KΩ	COMP	1/4W 5%	01121	CB3335	27-39311-0

PARTS LIST

DATA ROYAL ASSEMBLY: F230A SAWTOOTH GENERATOR BOARD — DATA ROYAL PART NO. 29-90042-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
SEMICONDUCTORS						
CR1		DIODE		JEDEC	1N914	27-95001-0
CR2		DIODE		JEDEC	1N914	27-95001-0
CR3		DIODE		JEDEC	1N914	27-95001-0
CR4		DIODE		JEDEC	1N914	27-95001-0
CR5		ZENER		JEDEC	1N5234	27-95251-0
CR6		DIODE		JEDEC	1N914	27-95001-0
CR7		DIODE		JEDEC	1N914	27-95001-0
CR8		DIODE		JEDEC	1N914	27-95001-0
CR9		DIODE		JEDEC	1N914	27-95001-0
TRANSISTORS						
Q1		U1899E		15818	U1899E	29-04533-0
Q2				JEDEC	2N3640	29-04504-0
Q3		DP1005		15818	DP1005	29-04534-0
Q4		40235		49671		29-04532-0
Q5				JEDEC	2N3640	29-04504-0
Q6				JEDEC	2N2218	29-04500-0
Q7				JEDEC	2N4916	29-04530-0
Q8		40235		49671		29-04532-0
Q9				JEDEC	2N3640	29-04504-0
Q10				JEDEC	2N4274	29-04508-0
INTEGRATED CIRCUITS						
I.C. 1		CA3018		49671		25-08705-0
I.C. 2		μA710C		17227		25-08701-0
I.C. 3		μA710C		17227		25-08701-0
I.C. 4		SN74H00N		01295		25-08707-0

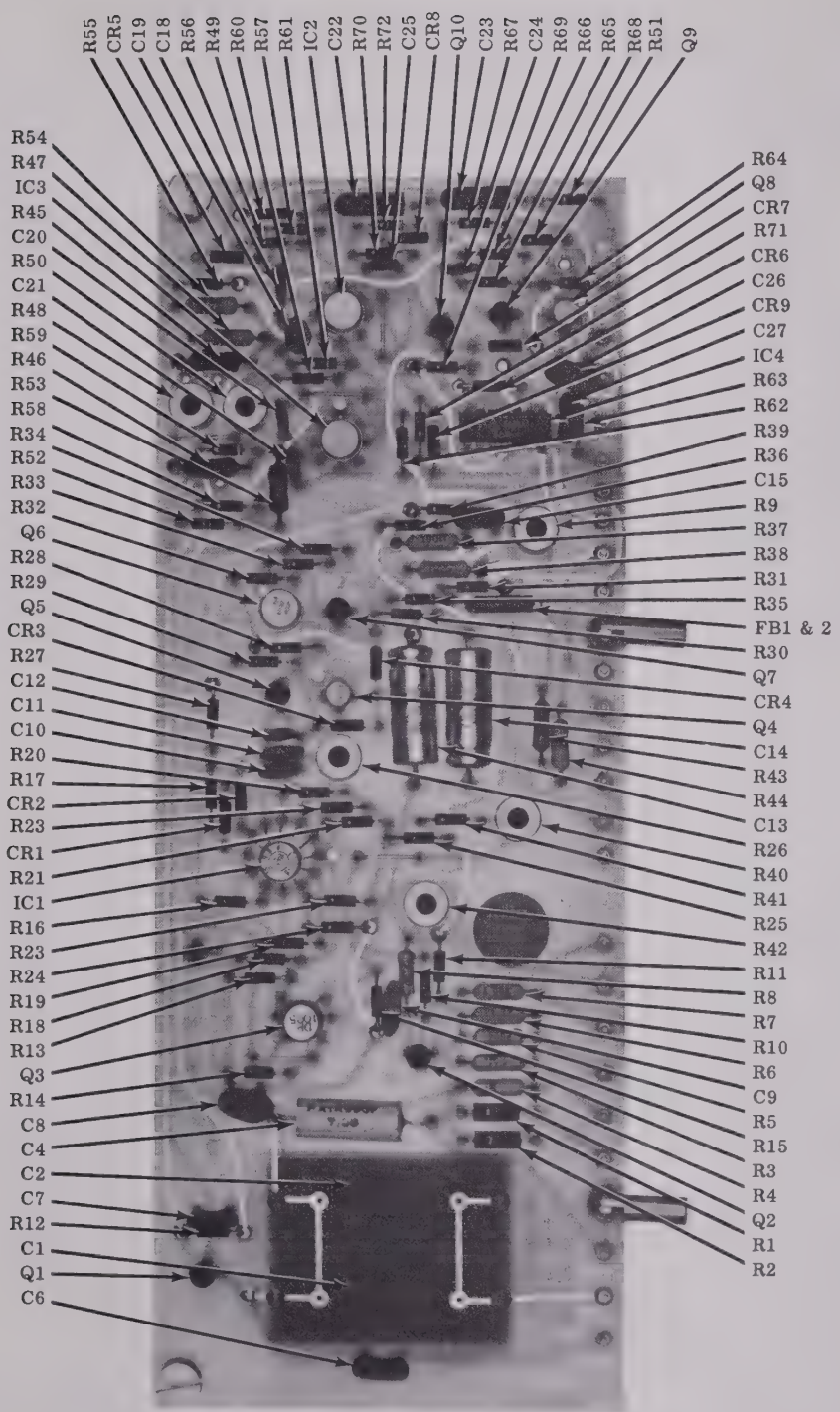
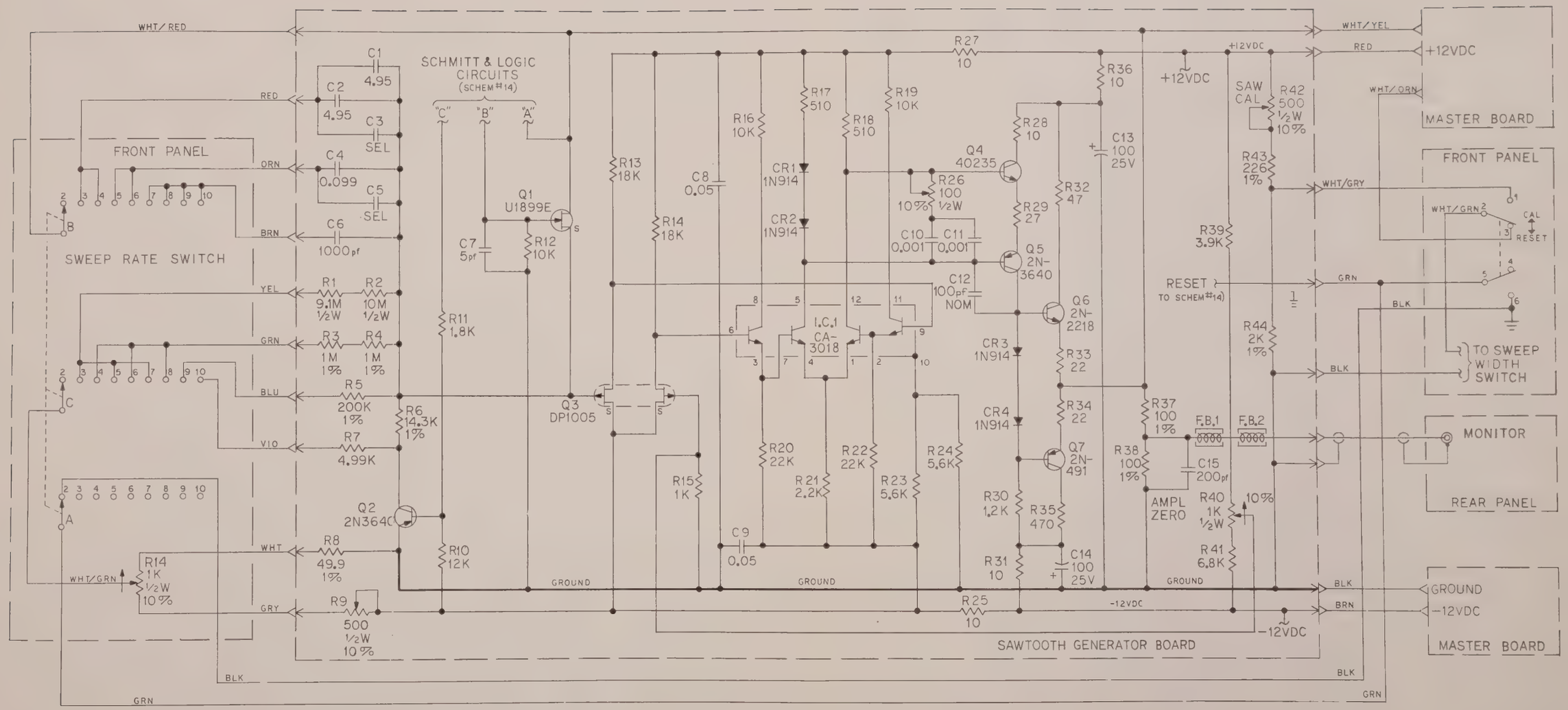


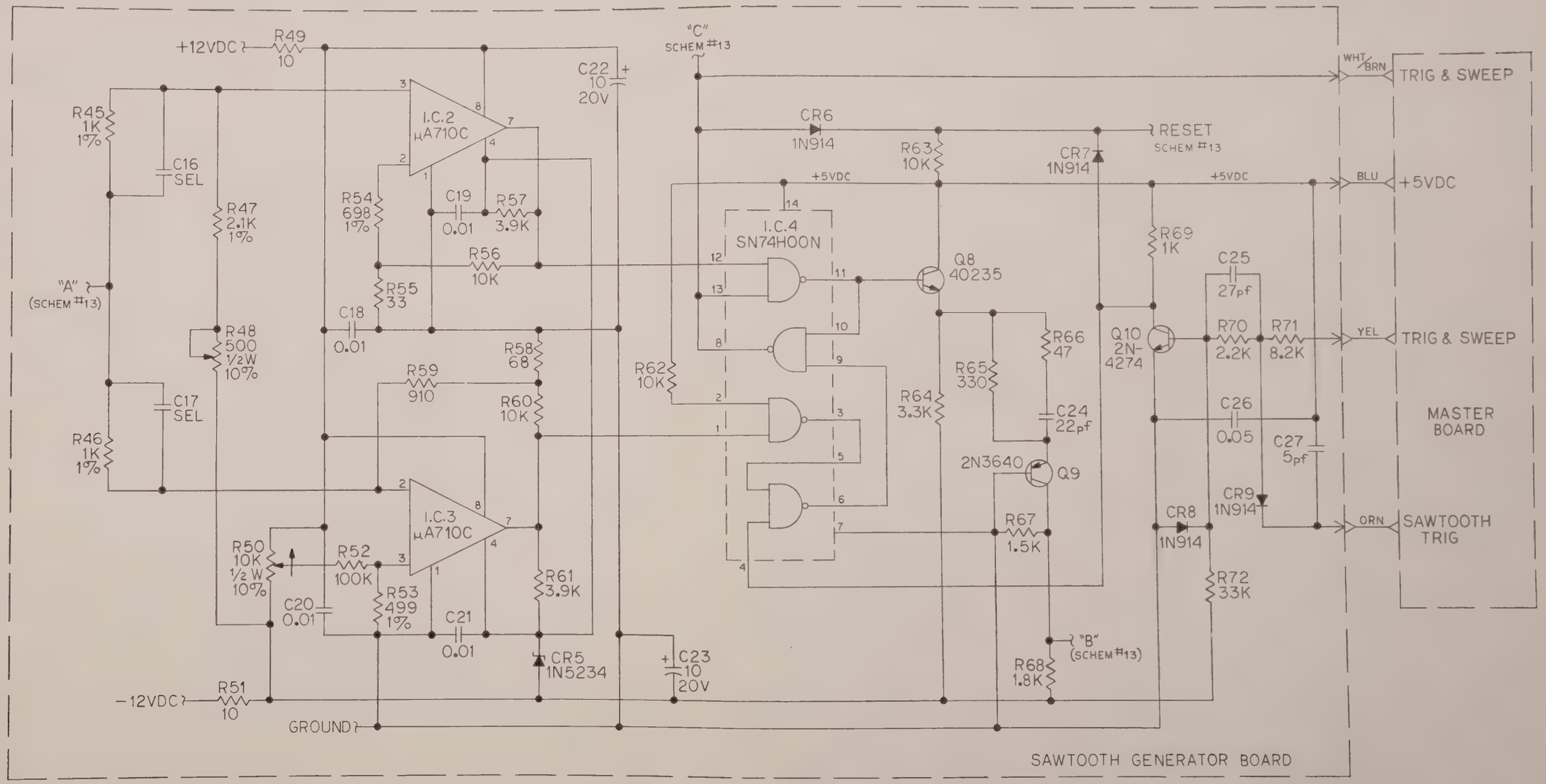
FIGURE 5-7

Sawtooth Generator Board



NOTES~UNLESS OTHERWISE SPECIFIED:
1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE ¼W, 5%.

SCHEMATIC #13
Integrator Circuits



NOTES~UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE ¼W, 5%.

SCHEMATIC #14
Schmitt & Logic Circuits

PARTS LIST

DATA ROYAL ASSEMBLY: F230A RANGE BOARD ASSEMBLY — DATA ROYAL PART NO. 29-02025

SCHEMATIC DESIGNATION	DESCRIPTION VALUE	TYPE	RATING	MANUFACTURER CODE	PART NO.	DATA ROYAL PART NO.
CAPACITORS						
C1 - C4	10μf	KIT		29085		21-64000-1
C5 - C7	1.0μf	KIT		29085		21-64001-1
C8 - C10	0.1μf	KIT		29085		21-64002-1
C11 - 13	0.01μf	KIT		29085		21-64003-1
C14	62pf	MICA	500V	04062	DM-15-620F	21-57622-0
C15	82pf	MICA	300V	04062	DM-15-821F	21-75623-0
C16	9-35pf	VAR		72982	338-002-940	21-63204-0
RESISTORS						
R1	833.3KΩ	FILM	1/4W 1%	12126	M1/4-833.K	27-46510-0
R2	2.5MΩ	FILM	1/4W 1%	12126	M1/4-2.5M	27-46512-0
R3	83.33KΩ	FILM	1/4W 1%	12126	M1/4-83.33K	27-46506-0
R4	250KΩ	FILM	1/4W 1%	12126	M1/4-250K	27-46508-0
R5	8.333KΩ	FILM	1/4W 1%	12126	M1/4-8.333K	27-46501-0
R6	25KΩ	FILM	1/4W 1%	12126	M1/4-25K	27-46504-0
SWITCH						
S1	SWITCH ASS'Y			29085		28-64002-1

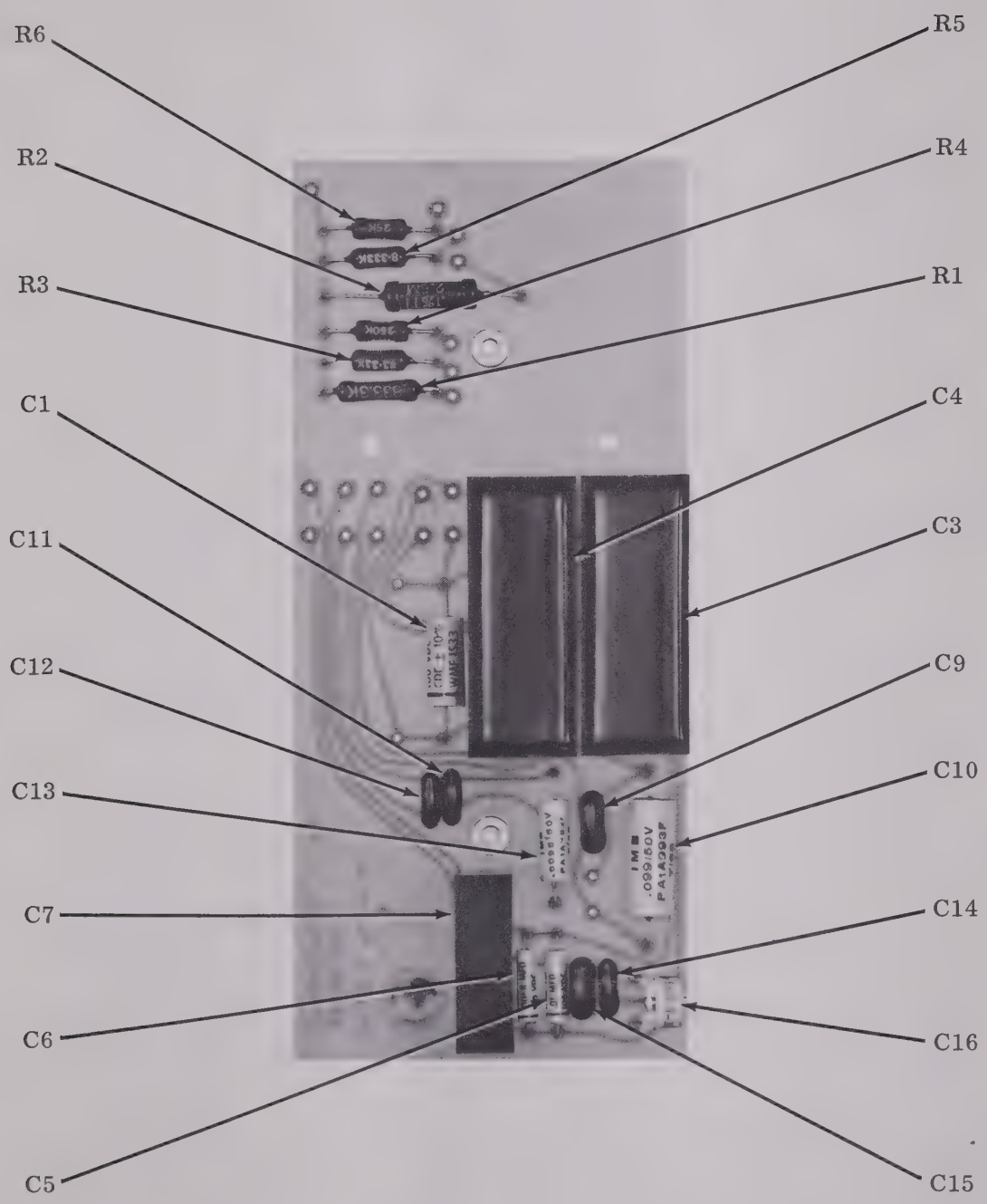
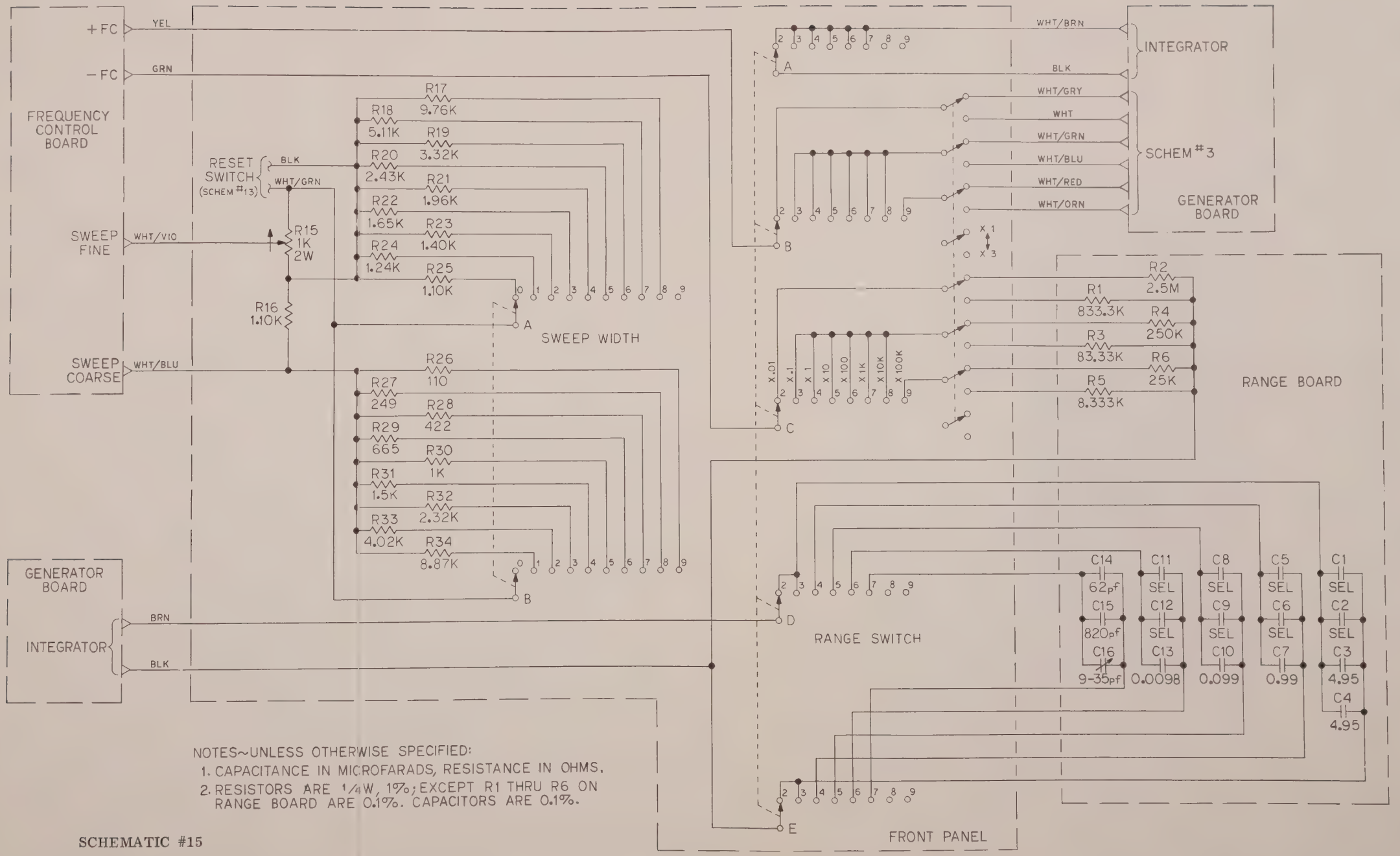


FIGURE 5-8
Range Board Assembly



NOTES~UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
2. RESISTORS ARE 1/4W, 1%; EXCEPT R1 THRU R6 ON RANGE BOARD ARE 0.1%. CAPACITORS ARE 0.1%.

SCHEMATIC #15

Range & Sweep Width Circuits

PARTS LIST

DATA ROYAL ASSEMBLY: F230A FRONT PANEL ASSEMBLY — DATA ROYAL PART NO. 29-90037-1

SCHEMATIC DESIGNATION	DESCRIPTION			MANUFACTURER		DATA ROYAL PART NO.
	VALUE	TYPE	RATING	CODE	PART NO.	
RESISTORS						
R1	2KΩ	VAR		73490	3351	27-50001-0
R2	100Ω	COMP	2W 5%	01121	HB1015	27-40252-0
R3	100Ω	COMP	2W 5%	01121	HB1015	27-40252-0
R4		VAR		01121	JJ94873	20-25500-1
R5	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R6	100Ω	COMP	1/4W 5%	01121	CB1015	27-39261-0
R7	4.99KΩ	FILM	1/4W 1%	12126	M1/4-4.99K	27-42887-0
R8	49.9Ω	FILM	1/4W 1%	12126	M1/4-49.9	27-42764-0
R9	453Ω	FILM	3/4W 1%	12126	M3/4-453	27-44252-0
R10	56.2Ω	FILM	1/4W 1%	12126	M1/4-56.2	27-42768-0
R11	549Ω	FILM	1/4W 1%	12126	M1/4-549	27-42824-0
R12	10KΩ	VAR	2W	44655	CM11-1031	27-49003-0
R13	10KΩ	VAR CON		78488	73-1121-2-2D1N-P	28-64013-1
R14	1KΩ	VAR CON		78488	73-1123-9-1D1N-P	28-64014-1
R15	1KΩ	VAR	2W	71590	HMP1000	27-49000-0
R16	1.10KΩ	FILM	1/4W 1%	12126	M1/4-1.10K	27-42983-0
R17	9.76KΩ	FILM	1/4W 1%	12126	M1/4-9.76K	27-42986-0
R18	5.11KΩ	FILM	1/4W 1%	12126	M1/4-5.11K	27-42888-0
R19	3.32KΩ	FILM	1/4W 1%	12126	M1/4-3.32K	27-42872-0
R20	2.43KΩ	FILM	1/4W 1%	12126	M1/4-2.43K	27-42981-0
R21	1.96KΩ	FILM	1/4W 1%	12126	M1/4-1.96K	27-42984-0
R22	1.65KΩ	FILM	1/4W 1%	12126	M1/4-1.65K	27-42857-0
R23	1.40KΩ	FILM	1/4W 1%	12126	M1/4-1.40K	27-42968-0
R24	1.24KΩ	FILM	1/4W 1%	12126	M1/4-1.24K	27-42849-0
R25	1.10KΩ	FILM	1/4W 1%	12126	M1/4-1.10K	27-42983-0
R26	110Ω	FILM	1/4W 1%	12126	M1/4-110	27-42982-0
R27	249Ω	FILM	1/4W 1%	12126	M1/4-249	27-42800-0
R28	442Ω	FILM	1/4W 1%	12126	M1/4-442	27-42815-0
R29	665Ω	FILM	1/4W 1%	12126	M1/4-665	27-42830-0
R30	1KΩ	FILM	1/4W 1%	12126	M1/4-1K	27-42846-0
R31	1.5KΩ	FILM	1/4W 1%	12126	M1/4-1.5K	27-42854-0
R32	2.32KΩ	FILM	1/4W 1%	12126	M1/4-2.32K	27-42985-0
R33	4.02KΩ	FILM	1/4W 1%	12126	M1/4-4.02K	27-42879-0
R34	8.87KΩ	FILM	1/4W 1%	12126	M1/4-8.87K	27-42908-0

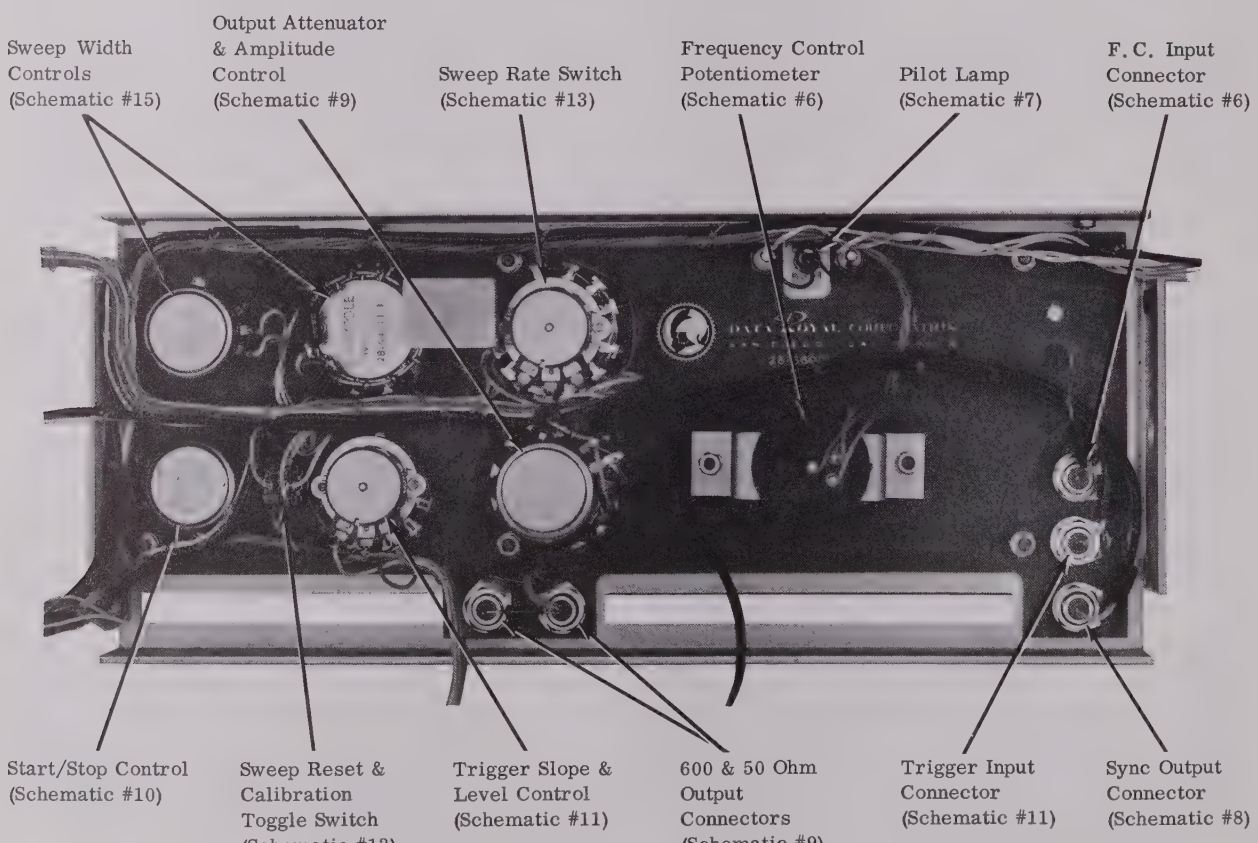
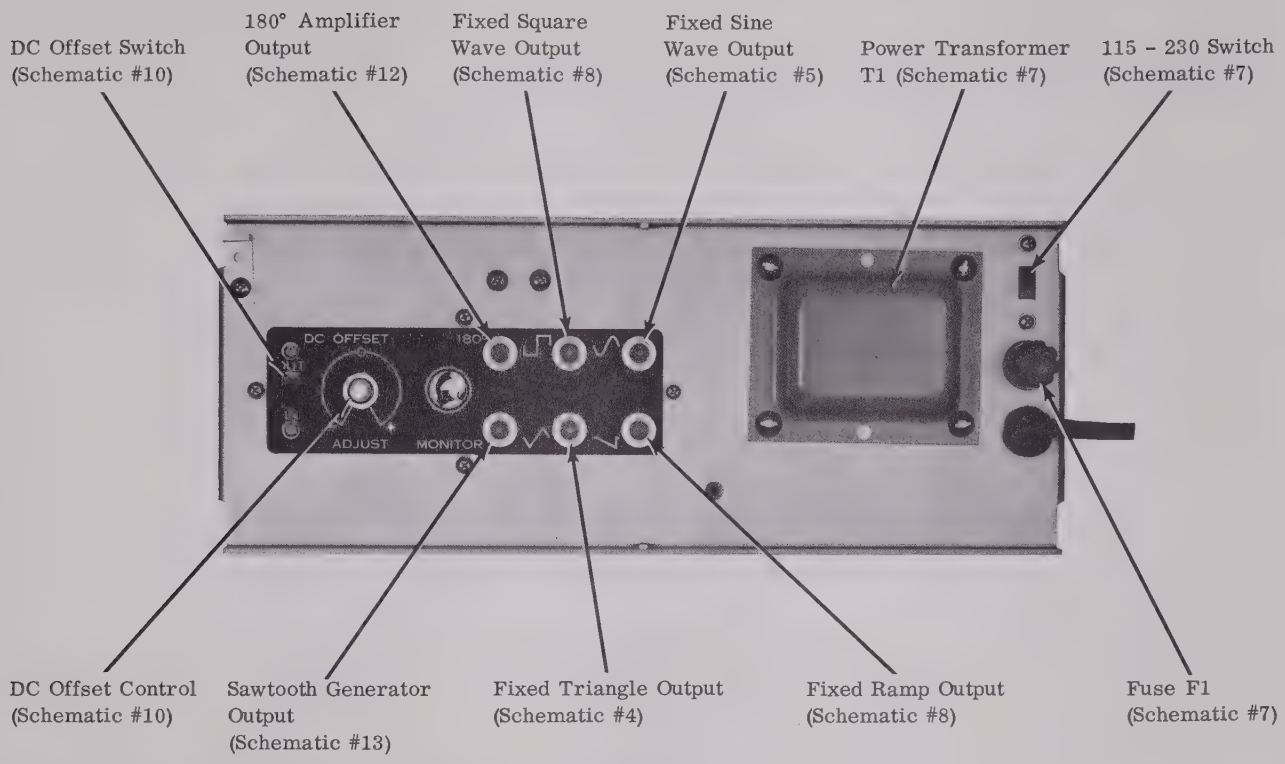
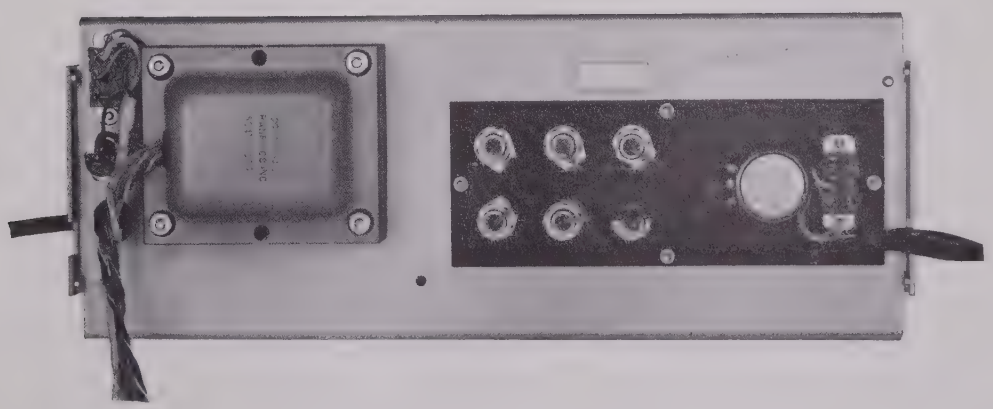

Sweep Width Controls (Schematic #15)
Output Attenuator & Amplitude Control (Schematic #9)
Sweep Rate Switch (Schematic #13)
Frequency Control Potentiometer (Schematic #6)
Pilot Lamp (Schematic #7)
F.C. Input Connector (Schematic #6)
Start/Stop Control (Schematic #10)
Sweep Reset & Calibration Toggle Switch (Schematic #13)
Trigger Slope & Level Control (Schematic #11)
600 & 50 Ohm Output Connectors (Schematic #9)
Trigger Input Connector (Schematic #11)
Sync Output Connector (Schematic #8)

FIGURE 5-9

Front Panel Assembly


DC Offset Switch (Schematic #10)
180° Amplifier Output (Schematic #12)
Fixed Square Wave Output (Schematic #8)
Fixed Sine Wave Output (Schematic #5)
Power Transformer T1 (Schematic #7)
115 - 230 Switch (Schematic #7)
DC OFFSET
180
ADJUST
MONITOR
DC Offset Control (Schematic #10)
Sawtooth Generator Output (Schematic #13)
Fixed Triangle Output (Schematic #4)
Fixed Ramp Output (Schematic #8)
Fuse F1 (Schematic #7)

OUTSIDE VIEW



INSIDE VIEW

FIGURE 5-10

Rear Panel Assembly

PARTS LIST

RECOMMENDED SPARE PARTS

The following is a list of the recommended spare parts required to maintain a specific number of instruments at a satisfactory level of performance for one year in an isolated area.

PART DESCRIPTION	PART NUMBER	1 UNIT	5 UNITS	10 UNITS
Fuse, 1/2 Amp, Slo-Blo	24-08000-0	2	4	6
Capacitor, Elect. 2700μf 25V	21-57200-0	2	4	6
Capacitor, Elect. 1300μf 50V	21-57213-0	2	4	6
Capacitor, Elect. 100μf 25V	21-57217-0	2	4	6
Capacitor, Elect. 2500μf 35V	21-57221-0	2	4	6
Tunnel Diode, 1N3719	27-95003-0	2	4	6
Diode, Zener, 1N5234	27-95251-0	1	2	3
Diode, Zener, 1N5232B	27-95255-0	1	2	3
Diode, Zener, 1N5235B	27-95258-0	1	2	3
Diode, Zener, 1N5242B	27-95259-0	1	2	3
Diode, Zener, 1N5252	27-95261-0	1	2	3
Diode, Zener, 1N5227B	27-95263-0	1	2	3
Diode, Zener, 1N5250	27-95264-0	1	2	3
Diode, MS-7000	27-95254-0	2	4	6
Integrated Circuit, μA709	25-08700-0	2	4	6
Integrated Circuit, μA710	25-08701-0	1	2	3
Integrated Circuit, CA-3018	25-08705-0	2	4	6
Integrated Circuit, CA-3030	25-08706-0	1	2	3
Integrated Circuit, SN74H00N	25-08707-0	1	2	3
Integrated Circuit, SN74H10N	25-08708-0	1	2	3
Integrated Circuit, SN74H71N	25-08709-0	1	2	3
Transistor, 2N2218	29-04500-0	1	2	3
Transistor, 2N3638	29-04503-0	1	2	3
Transistor, 2N3640	29-04504-0	1	2	3
Transistor, 2N4258	29-04507-0	1	2	3
Transistor, 2N4274	29-04508-0	1	2	3
Transistor, 2N4898	29-04510-0	1	2	3
Transistor, RCA 40235 or 2N5179	29-04512-0	3	6	9
Transistor, 2N4360	29-04513-0	1	2	3
Transistor, Dual FET, 2N3956	29-04514-0	1	2	3
Transistor, RCA 40250	29-04515-0	1	2	3
Transistor, RCA 40468	29-04516-0	1	2	3
Transistor, 2N 3866	29-04522-0	1	2	3
Transistor, 2N 4890	29-04524-0	1	2	3
Transistor, 2N 5160	29-04525-0	1	2	3
Transistor, FET, U1899E	29-04533-0	1	2	3
Transistor, Dual FET, DP1005	29-04534-0	1	2	3

TABLE 6-1

LIST OF MANUFACTURERS

FEDERAL SUPPLY CODE TO NAME

FEDERAL SUPPLY CODE	MANUFACTURER	ADDRESS
00853	Sangamo Electric Company	Pickens, South Carolina
01121	Allen Bradley Company	Milwaukee, Wisconsin
01295	Texas Instruments, Inc.	Dallas, Texas
04062	Elmenco Products Company	New York, New York
04387	Dale Electronics, Inc.	Burbank, California
04713	Motorola Inc. Semiconductors Products Division	Phoenix, Arizona
07115	Corning Glass, Electronic Components	Bradford, Pennsylvania
12126	Kidco, Inc.	Medford, New Jersey
12406	Elpac, Inc.	Fullerton, California
14099	Semtech Corporation	Newbury Park, California
14655	Cornell-Dublier Electric Corp.	Newark, New Jersey
15818	Amelco Division, Teledyne Corp.	Mountain View, California
17227	Raytheon Company	Mountain View, California
17856	Silliconix, Inc.	Sunnyvale, California
21845	Solitron Devices, Inc.	Riviera Beach, Florida
27556	IMB	Santa Fe Springs, California
29085	Data Royal Corporation	San Diego, California
44655	Ohmite Manufacturing Company	Skokie, Illinois
49671	Radio Corporation Of America	New York, New York
56289	Sprague Electric Company	North Adams, Massachusetts
71002	Birnbach Radio Company	New York, New York
71590	Centralab	Milwaukee, Wisconsin
72982	Erie Technological Products	Erie, Pennsylvania
73490	Beckman Helipot Corporation	South Pasadena, California
75915	Littelfuse, Inc.	Des Plaines, Illinois
78488	Stackpole Carbon Company	St. Marys, Pennsylvania
81073	Grayhill, Inc.	La Grange, Illinois
82389	Switchcraft, Inc.	Chicago, Illinois
84171	Arco Electronics Company	Great Neck, New York
88140	Cutler-Hammer, Inc.	Lincoln, Illinois
*	Kemet	Granville, South Carolina

* No Federal Supply Code Number Assigned.

ONE YEAR UNCONDITIONAL

WARRANTY

DATA ROYAL CORPORATION hereby warrants to each original purchaser of all instruments of Data Royal Corporation manufacture as follows:

I. At the time of delivery of all instruments to the original purchaser thereof, Data Royal Corporation UNCONDITIONALLY WARRANTS that all of such instruments shall be free from defects in parts, materials, and workmanship; and

II. Commencing with the date of delivery of all instruments to the original purchaser thereof, which delivery date for purposes of this warranty shall be deemed to be Data Royal Corporation's original shipment date, AND FOR A PERIOD EXPIRING ONE (1) YEAR FROM SAID DATE, Data Royal Corporation UNCONDITIONALLY WARRANTS that all such instruments shall remain free from defects in parts, materials and workmanship.

In the event any instrument shall fail to meet the terms of this warranty, Data Royal Corporation agrees that if the original purchaser of any such instrument shall:

(1) Give to Data Royal Corporation's customer service department prompt notice in writing of the nature of any suspected defects; and

(2) Upon receipt of written authorization and shipping instructions from Data Royal Corporation, return the instrument with suspected defects, transportation charges prepaid, to Data Royal Corporation's main plant located in San Diego, California; then Data Royal Corporation shall replace any and all defective parts or materials and shall repair any and all defective workmanship and shall return the instrument, TRANSPORTATION CHARGES COLLECT, in good working order and state of repair to the original purchaser thereof, or in the alternative, Data Royal Corporation shall have the option to replace any such defective instrument by substituting a new instrument of the same type therefor, ALL WITHOUT ANY CHARGE WHATSOEVER:

The warranties herein contained shall not obligate Data Royal Corporation in any manner whatsoever with respect to, and shall not be applicable to, any defects which after an inspection of the instrument by Data Royal Corporation are not to Data Royal Corporation's reasonable satisfaction demonstrably the result of defective parts, materials or workmanship.

Data Royal Corporation reserves the right to modify or change the design or appearance of any of its instruments as it deems desirable. Nothing herein contained shall preclude such right or create any obligation to effect such changes on units previously purchased.

The remedies herein specified in the event of a breach of any of the warranties herein contained shall be the sole and exclusive remedies for such breach.

The warranties herein contained are intended to be and shall be construed as being in addition to and cumulative to all implied warranties contained in the Uniform Commercial Code, provided, however, that in the event of any breach by Data Royal Corporation of any of the implied warranties contained in the Uniform Commercial Code neither the purchaser of any Data Royal Corporation product, nor any other person, shall be entitled to recover by reason of such breach any incidental damages or consequential damages as those terms are defined in subsection 2-715 of the Uniform Commercial Code.

All warranties herein contained shall run only in favor of the original purchaser of Data Royal Corporation's instruments and all such warranties shall immediately terminate and become null and void and of no further force or effect whatsoever upon the sale or other transfer of any such instrument by the original purchaser. The warranties herein contained constitute the sole and exclusive warranties made by Data Royal Corporation of its instruments and no other express warranties not herein contained are given and no affirmation of fact, promise or representation made by any agent, employee or representative of Data Royal Corporation shall constitute a warranty. No agent, employee or representative of Data Royal Corporation has any authority to bind Data Royal Corporation in any affirmation of fact, promise, representation or warranty not herein expressly contained.

The above statements and warranty constitute a part of Data Royal Corporation's Standard Terms and Conditions of Sale as published in our Order Acknowledgement which together is Data Royal Corporation's warranty in its entirety.

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